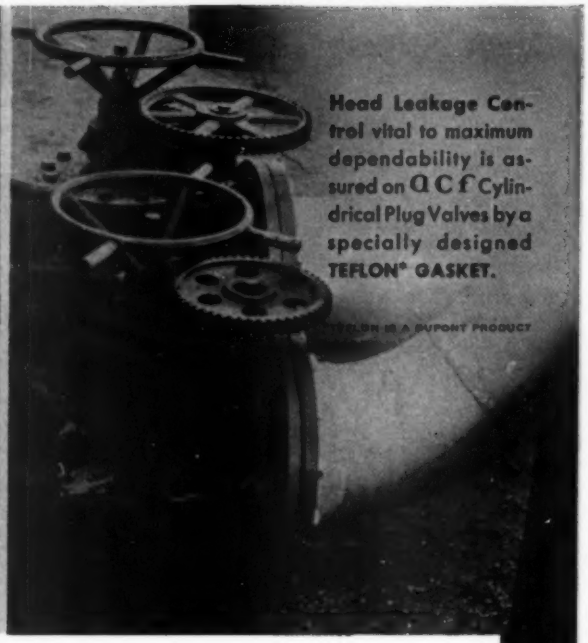
WATER & SEWAGE WORKS

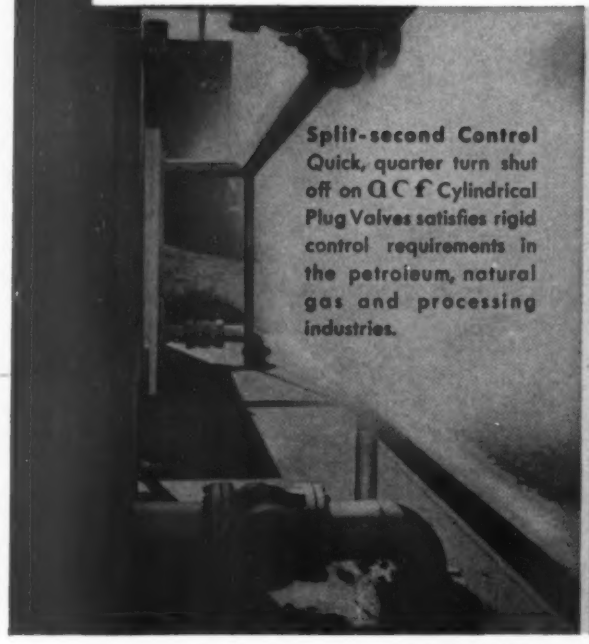
Knife-edge Rotary Action of the acf Cylindrical Plug Valve clears obstructions, eliminates stoppages, insures constant flow.



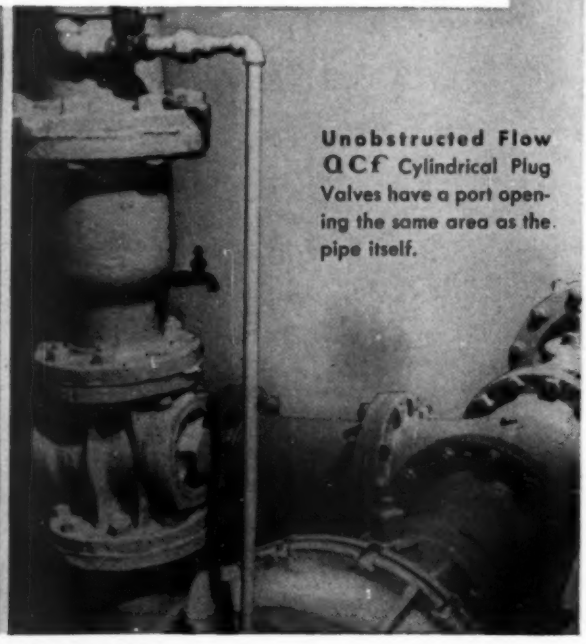
Head Leakage Control vital to maximum dependability is assured on acf Cylindrical Plug Valves by a specially designed TEFLON* GASKET.

*TEFLON IS A DUPONT PRODUCT

QUALITY THAT PAYS OFF



Split-second Control Quick, quarter turn shut off on acf Cylindrical Plug Valves satisfies rigid control requirements in the petroleum, natural gas and processing industries.



Unobstructed Flow acf Cylindrical Plug Valves have a port opening the same area as the pipe itself.

Rectangular Port and Full Round Port

acf

Representatives in 50 Principal Cities

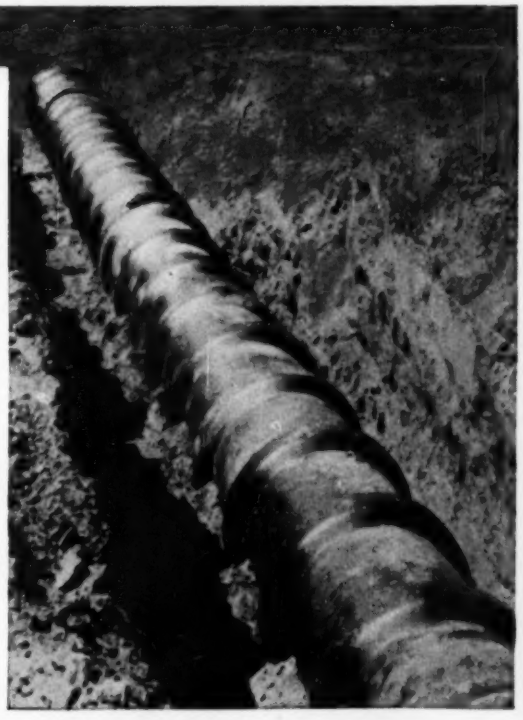
CYLINDRICAL FULL PIPE AREA

PLUG VALVES

Write for descriptive Catalog 5-WS to
A C F Industries, Incorporated, Valve Division,
1501 E. Ferry Avenue, Detroit 11, Michigan.

The Disappearing Act

that never fails



A billion-mile network of buried faith lies stretched across America. It's Vitrified Clay Pipe — the product that disappears underground . . . and *has* to be trusted. Clay Pipe is sealed in by streets and sidewalks . . . blocked off by building foundations . . . piled over with earth and rock.

Everybody trusts it, because Clay Pipe has a vital job to do, and it must not fail. Yet — nobody worries about that vast underground network of sanitary protection. Few people even think about it. What greater tribute could be paid to a product's dependability?

Of all the materials that are used in the construction of modern homes and cities, none is more essential than Vitrified Clay Pipe. It disappears underground, so it's got to be good. It guards against disease, so it's got to be good. It gets no maintenance, so it's got to be good.

And you know it *is* good, because it is guaranteed for 50 years. It's the only pipe that *never wears out,* and the Clay Pipe Industry is mighty proud of it.

Vitrified CLAY PIPE

C-354-6

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HTH TABLET HYPOCHLORINATION—For accurate metering and feeding of hypochlorite solutions, HTH Tablets and the HTH Tablet Hypochlorinator provide a low-cost method that offers you new convenience and dependability. It is applicable to water, sewage, and industrial wastes treatment as well as to pool chlorination.

For complete information and descriptive literature call your Mathieson HTH distributor or write today.

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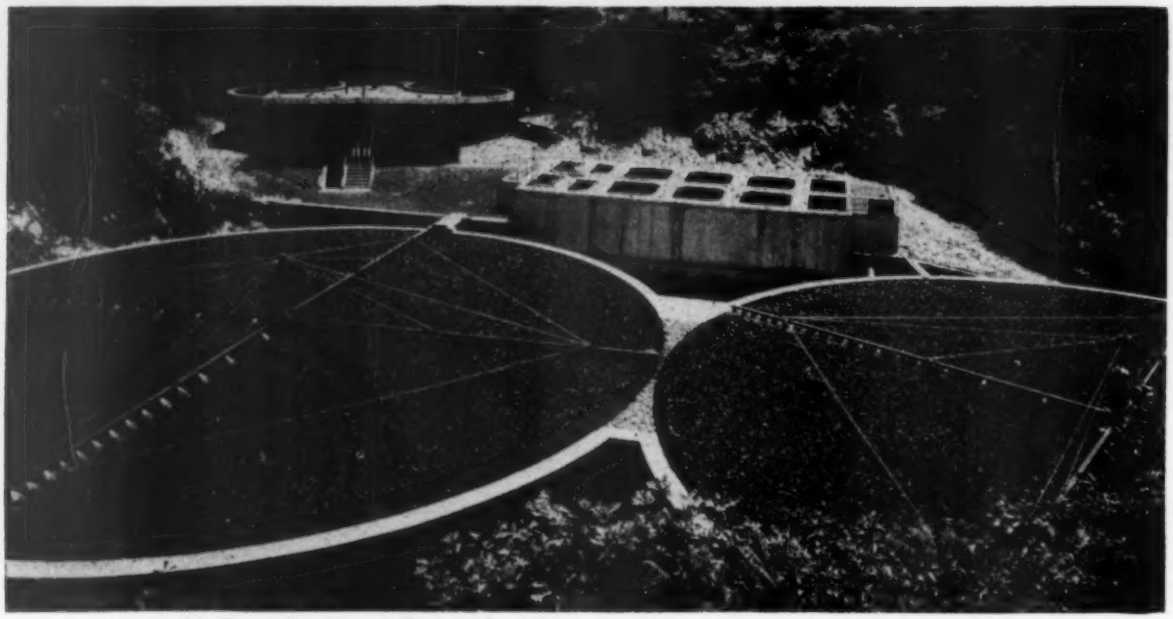
Foreground: enlarged filter bed with 2 PFT 100′ Rotary Distributors



At Downingtown, Pennsylvania . . .

Existing structures are put to better use

WITH MODERN PFT EQUIPMENT

Serving a population of 10,000, Downingtown's old (1916) sewage treatment plant faced the problem of capacity—its circular Imhoff Tank and fixed nozzle filter bed were inadequate for current needs. Solution: expansion from present structures using *PFT equipment for more effective treatment!*

To improve the filter system, the original fixed nozzle filter bed was enlarged and converted into two circular filters, each 100 ft. in diameter. A *PFT Rotary Distributor* is installed on each bed for uniform distribution and trouble-free service. Specially designed spreader jets on the PFT Distributors reduce clogging and are easily cleaned.

The Imhoff Tank was converted to a digestion tank and a second tank was added, both 25′ in diameter. A *PFT Floating Cover* is installed in each digester for positive scum submergence, safe utilization of gas and simplified operation. A PFT Supernatant Liquor Selector in each digester provides automatic, continuous withdrawal of the best digester liquor.

A new control building located between the digesters contains additional PFT equipment for operational control: (1) *Supernatant Gauge, Sight Glass and Sampler* units for close control of supernatant withdrawal, (2) *Gas Safety Equipment*, (3) *Heater & Heat Exchanger* unit with capacity of 250,000 B.t.u. per hour. Fired by either gas or oil, the heater utilizes all gas produced by the digesters, switching to oil only when necessary. Heating *externally*, the unit allows complete accessibility and simplifies cleaning and maintenance.

Design of plant by / *Edwin B. Wagner, Downingtown, Pa.*

P.F.T.

waste treatment equipment exclusively since 1893

PACIFIC FLUSH TANK CO.
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for all chemical feed lines . . .

try NEW DUR-ACE PIPE

a tough, corrosion-resistant plastic with a good cost factor

Dur-Ace is a new corrosion-resistant, rigid plastic pipe with exceptional impact strength and toughness . . . good for original installations and replacement work on all chemical feed lines in water and sewage treating plants . . . with low first cost and long life.

In water and sewage plants, Dur-Ace already is successfully handling filter alum, ferrous sulphate, ferric chloride, lime slurry, chlorine, sodium chlorite, chlorine dioxide, ammonium hydroxide, and polyphosphates.

Light in weight, Dur-Ace is odorless, tasteless and non-contaminating. It maintains good strength from minus 40 deg. F. to 170 deg. F. It's corrosion-resistant on the **outside,** too, and saves the cost of painting. Electrolytic corrosion and bacteria have no effect on Dur-Ace, so it's excellent for underground lines handling chemicals, water, brines, fueloil, etc.

Successful field installations of thousands of Dur-Ace molded fittings have been made. We have job-proved performance data covering a wide variety of corrosives. Dur-Ace pipe is available in sizes from ½ to 2", Standard and Extra Heavy, with a wide variety of fittings.

***Dur-Ace** is the eighth basic type of corrosion-resistant pipe available from ACE . . . including materials for high pressures, high temperatures, strong acids, organic solvents, etc., and pipe sizes to 24" and above. Consult ACE first with any corrosion problem.*

CHEMICAL RESISTANCE AT 77 DEG. F.

SATISFACTORY		LIMITED	UNSUITABLE
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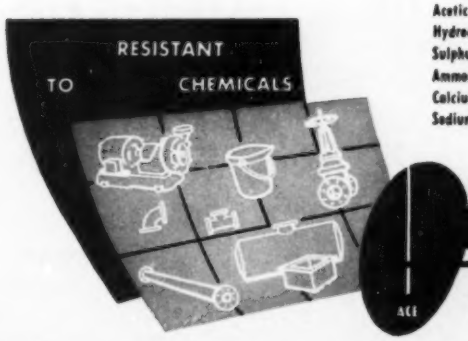
Sulphuric Acid 50%	Bleaches	Nitric Acid 10%	Chlorinated Solvents
Ammonium Hydroxide 28%	Most Plating Sols.	Phosphoric Acid 50%	Esters
Calcium Hydroxide	Oil (SAE 10-30)	Alcohols	Ketones
Sodium Hydroxide 20%		Vegetable Oils	



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CE rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET · NEW YORK 13, N. Y.

Alco STEEL PIPE used for Water Supply in New York City's Borough of Queens

When a large new line was planned for New York City's thriving Borough of Queens, Alco received an order for Electric Welded Steel Pipe—17,250 ft of 72-in. and 1000 ft of 60- to 20-in. pipe, plus specials.

In strict accordance with specifications of the City's Department of Water Supply, Gas and Electricity, the pipe is fabricated of ½-in. thick steel plate, lined on the inside and coated on the outside with coal-tar enamel, and wrapped with coal-tar saturated asbestos felt. Field joints are riveted.

For your specifications, Alco Electric Welded Steel Pipe is available in diameters from 20 to 120 in., and lengths to 40 ft without girth seams in diameters 30 in. and up.

It is the choice of engineers and contractors all over the country for its strength, efficiency, economy and long life. Consider Electric Welded Steel Pipe for your installation—special or standard, whatever its size. For complete technical data—and expert assistance with your special problems—contact your nearest Alco Products sales representative.

THE WORLD'S LARGEST water system grows even larger as New York City's Borough of Queens adds 17,250 ft of 72-in. and 1000 ft of 60- to 20-in. Alco Electric Welded Steel Pipe.

COMPLETE FACILITIES for fabricating pipe, connections and specials enable Alco to meet your installation requirements at low first cost and with superior quality.

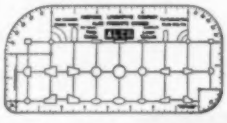
Remember these Key features of Alco Steel Pipe

STRONG: Unaffected by vibration. Maximum resistance to shock, and to overloading from earth movement and washout.

EFFICIENT: Positively watertight. Minimum number of field joints. Smooth coal-tar enameled interior surface for highest flow rate.

ECONOMICAL: Low first cost. Long lengths, light weight for easy installation.

DURABLE: Life in water supply installations estimated conservatively at 75 to 100 years.



For information on how to obtain one of these handy Alco Piping Templates, write to your nearest Alco Products Sales Office.

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by the industries it serves

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Water Wells • Vertical Turbine Pumps • Water Treatment

The test of a century

F.P.G.

This is Lancaster, Pa., County seat in one of the most highly cultivated farming districts in America.

Bettmann Archive

Old print showing southwest view of Lancaster about 100 years ago.

MODERNIZED cast iron

is the test that tells!

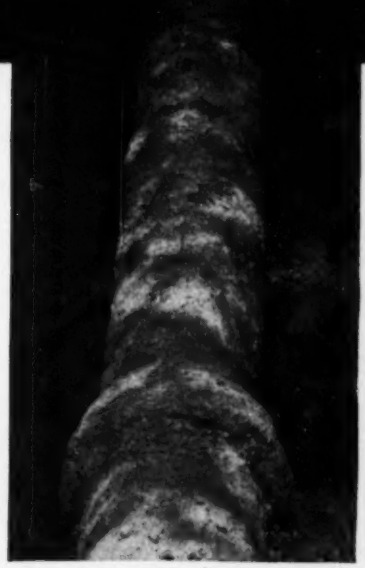
LANCASTER installed cast iron water mains 100 years ago . . . and installs them today.

Lancaster, Pa., has grown in 100 years from about 12,000 population to nearly 65,000 — but it has not outgrown the habit of buying cast iron pipe. From four miles of water mains a century ago, the present distribution system has increased to 105 miles of pipe—all of it cast iron pipe. Services have grown from 2,000 to nearly 20,000.

The word "test" means—"*put to the proof*"—according to the dictionary. Well, 60 utilities have put cast iron pipe to the *proof* for a century—a test to end all tests. They installed cast iron water or gas mains 100 years, or more, ago that are still in service. Yes, the test of a century has *proved* beyond question the long life and low cost per service year of cast iron pipe.

Cast iron pipe has been a rugged, long-lived product from the earliest days. Today's *modernized* cast iron pipe, centrifugally cast, is even stronger, tougher, and more uniform in quality. And, where needed and specified, it is centrifugally lined with cement mortar to assure sustained carrying capacity throughout the long life of the pipe.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3.



This cast iron water main laid in 1835 by the Bureau of Water of Lancaster is still functioning after 119 years of service.

CAST Q IRON

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

pipe FOR MODERN WATER WORKS OPERATION

Section of 84-in. concrete pipe for an underwater outfall is lowered into position from a barge in the Delaware River.

Capped timber piles support sections of 84-in. concrete pipe across a dredge-filled marsh area to the treatment plant.

Backbone of 50-Mile Sewer System in Delaware is CONCRETE PIPE

Concrete pipe comprises the backbone of a gigantic new interceptor sewer system in New Castle County, Del. The system is designed to serve two-thirds of the state's population and nearly half its industry.

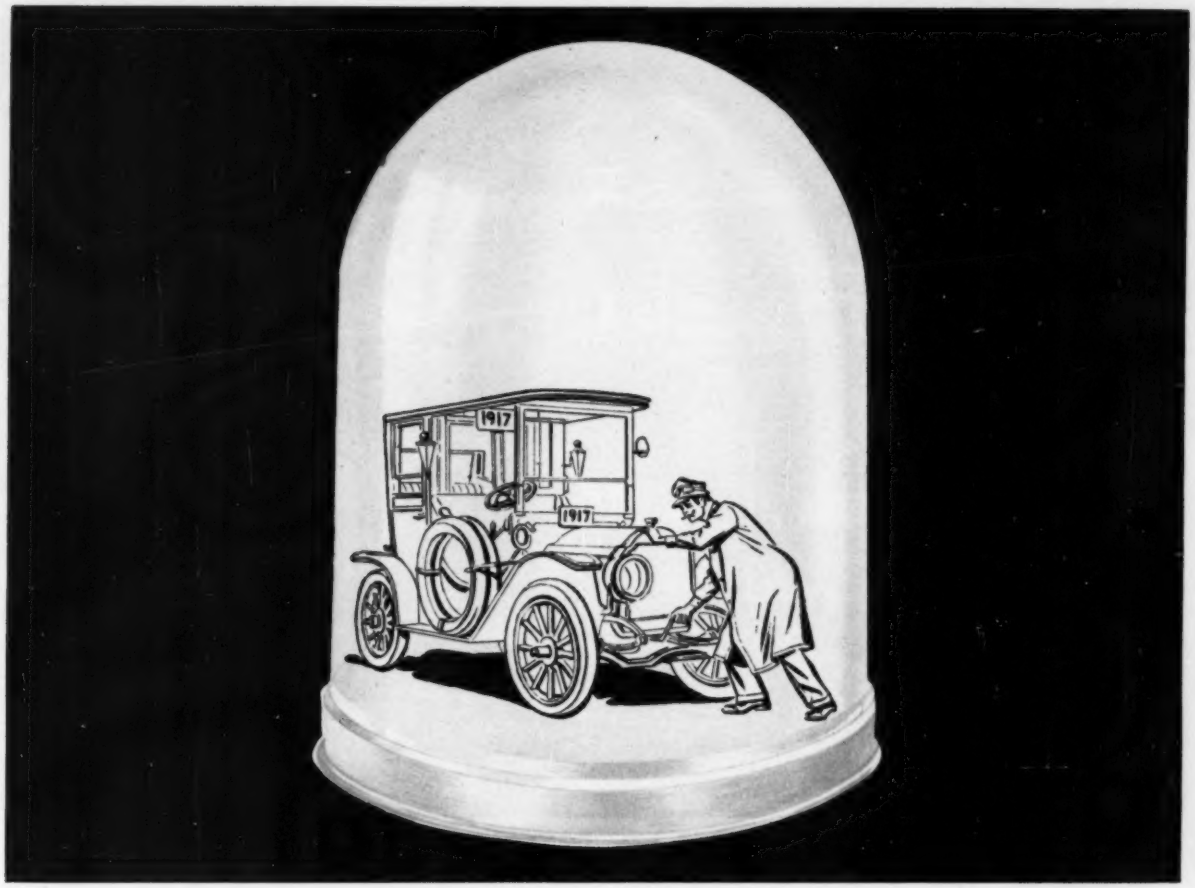
Fifty miles of collectors funnel sewage into an 84-in. concrete force main to the treatment plant. From there it is discharged into the Delaware River through an 84-in. concrete pipe underwater outfall.

Concrete pipe demonstrated its adaptability to any combination of site or soil conditions or drainage requirements. It was laid in dredge-filled marshland, in 30-ft. trenches, in treacherous and unstable soil between tight sheeting and jacked under pavement.

Adaptability to tough conditions is only one reason for specifying concrete pipe for sewers. Its strength resists severe impact and heavy overburdens, its durability gives long, trouble-free service, its smooth interior finish provides maximum hydraulic capacity and resistance to abrasion and its dense structure and tight joints assure minimum leakage and infiltration.

AMERICAN CONCRETE PIPE ASSOCIATION

228 NORTH LA SALLE STREET, CHICAGO 1, ILLINOIS



how much does it cost... to "crank" an old style chlorinator?

The automobile self-type starter isn't news any more—nobody ever cranks a car these days. "Cranking" an old-style chlorinator is equally out-dated.

The F&P mechanical, instrument-type chlorinator is sweeping the country, sales mount month by month. Why? Because municipality after municipality, consulting engineer after consulting engineer, reports the same facts: F&P chlorinators are lower in first cost, are easier to handle, because they are so simple in design, so light in weight, so modern in construction. More important, however, it is always stressed that F&P chlorinators require practically no maintenance, practically no spare parts.

We claim that if you are operating a chlorinator that has a bell jar on it *you need a new chlorinator.* You are "cranking" an old, costly, inefficient chlorinator. Everybody knows that dry chlorine is not corrosive—but that as soon as you put the chlorine in contact with water or water vapor it becomes corrosive. That's what the water tray types of chlorinators do—put dry, non-corrosive chlorine in contact with water and make corrosive vapor out of it. It's not engineering sense and the way to avoid it—and the resulting expensive maintenance—is to get F&P *mechanical, instrument type chlorinators.*

Don't refrain from writing us because you don't need additional chlorinating capacity right now. Moreover if it is time for a major overhaul or a rebuilding of your bell jar chlorinator, let us quote you for doing this work. We will give you what you may not have gotten previously—a firm price for doing the job before we start on it. The price will be a reasonable one, but we'll also quote you a price for replacing the chlorinator and if you want to spread the cost of the new one by time payments or if you want a lease arrangement, you can have it. Chances are you cannot justify further overhaul or further rebuilding—even at our *fair* price for the work.

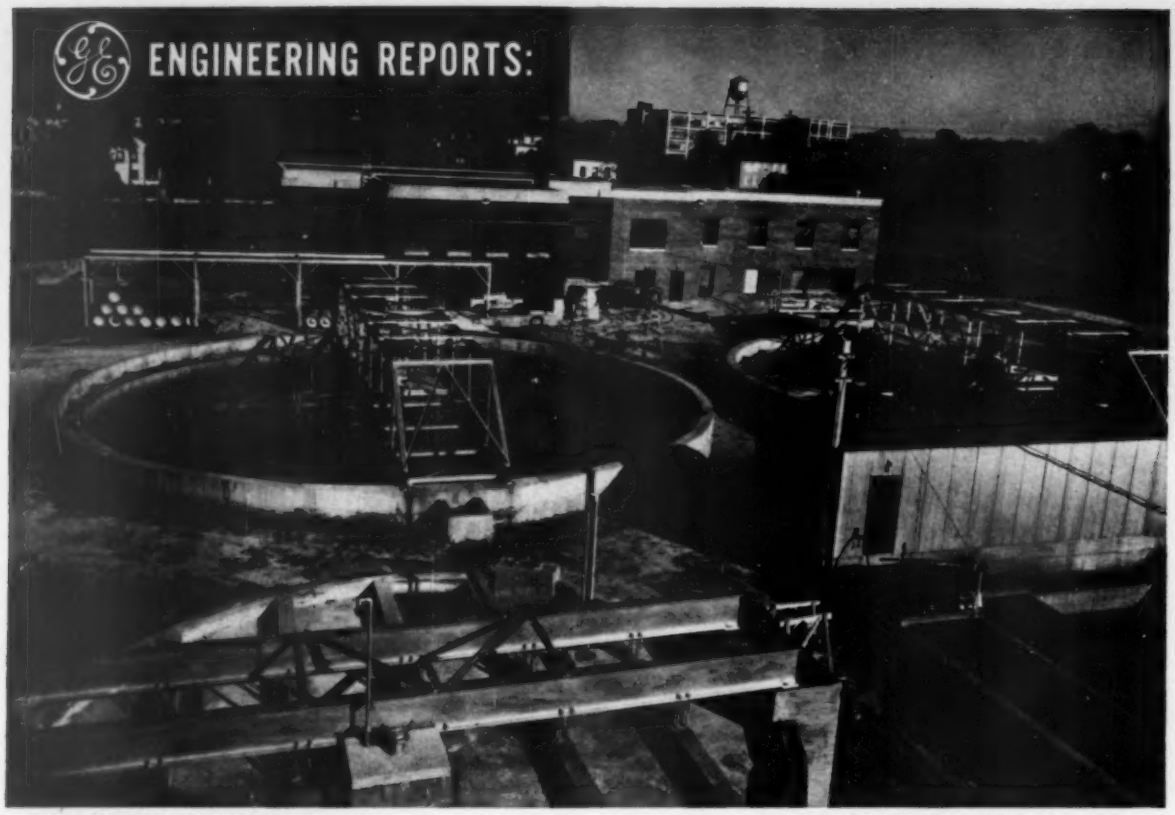
complete process instrumentation

FISCHER & PORTER CO.

224 Fischer Road, Hatboro, Penna.

18 YEARS EXPERIENCE SUCCESSFULLY MANUFACTURING CHLORINE FLOW METERING EQUIPMENT

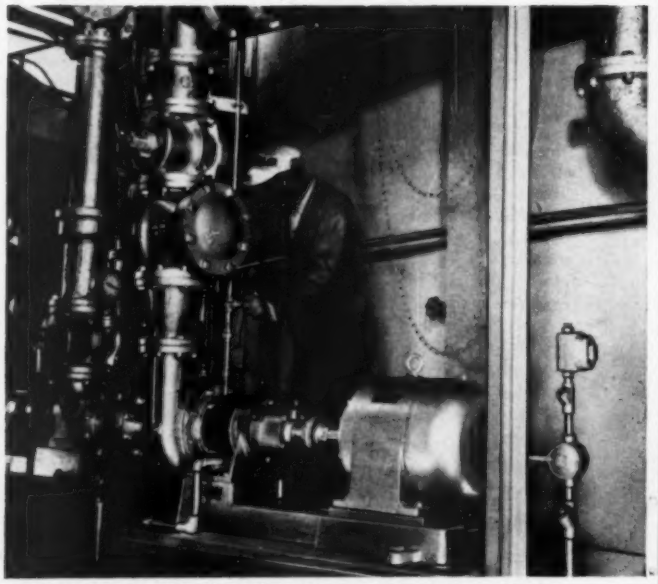
LA 1010 A



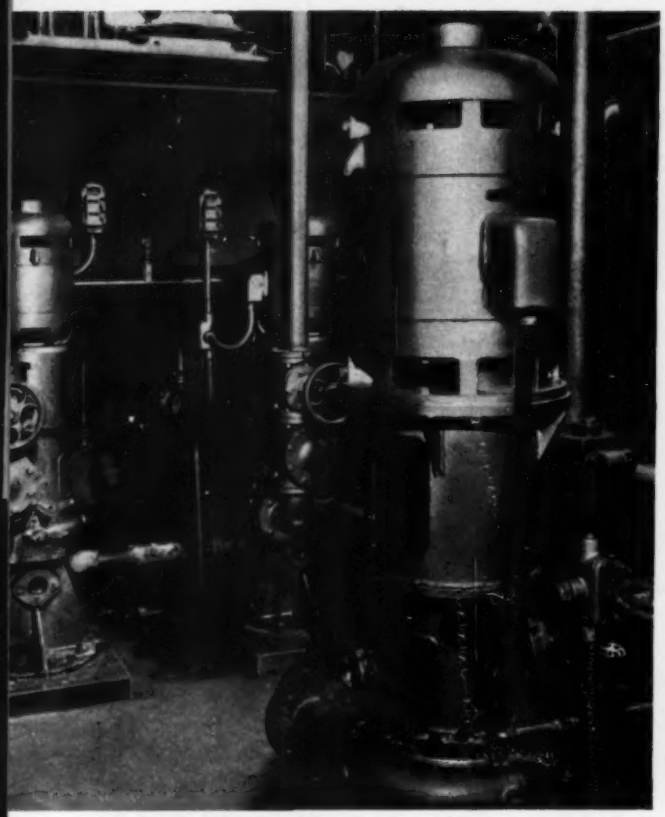
REMODELED AND EXPANDED FACILITIES at the City of Norwalk Sewage Treatment Plant showing (foreground to background) digester, sludge pumping station, sedimentation tanks, and screening and main pumping building. The plant now has a capacity of 22.5 mgd after having been rebuilt to meet the demands of a substantial population increase.

Norwalk remodels sewage plant to bring

IN THE MAIN PUMP ROOM of the remodeled City of Norwalk Sewage Treatment Plant, four G-E 75-hp motors provide rugged, efficient drive for the main Worthington pumps.



TOUGH OPERATING CONDITIONS encountered in the digester control room are met by totally enclosed G-E 7½-hp Tri-Clad motor driving flushing water and scum-breaking pump.



EFFICIENT DRIVE for the effluent flushing water pump is provided by a vertical 10-hp G-E Tri-Clad* motor. In the rear two smaller Tri-Clad motors drive elutriation water pumps.

* Reg. trade-mark of General Electric Co.

ENGINEERED to meet exact requirements of the Norwalk plant, G-E metal-clad Cabinetrol* panel provides centralized control and instrumentation needed in the main pumping building.

CLEAN WATERS to Long Island Sound

G-E equipment helps city increase plant pumping capacity and clean up recreation areas

The 25-year-old sewage treatment plant in Norwalk, Connecticut, was recently rebuilt to meet the demands of a substantial population increase. The old facilities were expanded to a capacity of 22.5 mgd and are now large enough to handle more safely all the city's waste. With this new plant, Norwalk has met the need for year-around protection of Norwalk Harbor oyster beds and has helped keep Long Island Sound resort areas safer for bathing and recreation.

Consulting engineers Metcalf & Eddy, electrical contractor County Electric Company, and general contractor De Force Construction Company worked with G-E application and field-service engineers in specifying and installing the electrical equipment.

SPECIALISTS IN SEWAGE-PLANT ELECTRIFICATION, G-E application engineers are ready to work with your engineers, consultants, and contractors. Contact your local G-E Apparatus Sales Representative early in the planning stage. 666-85

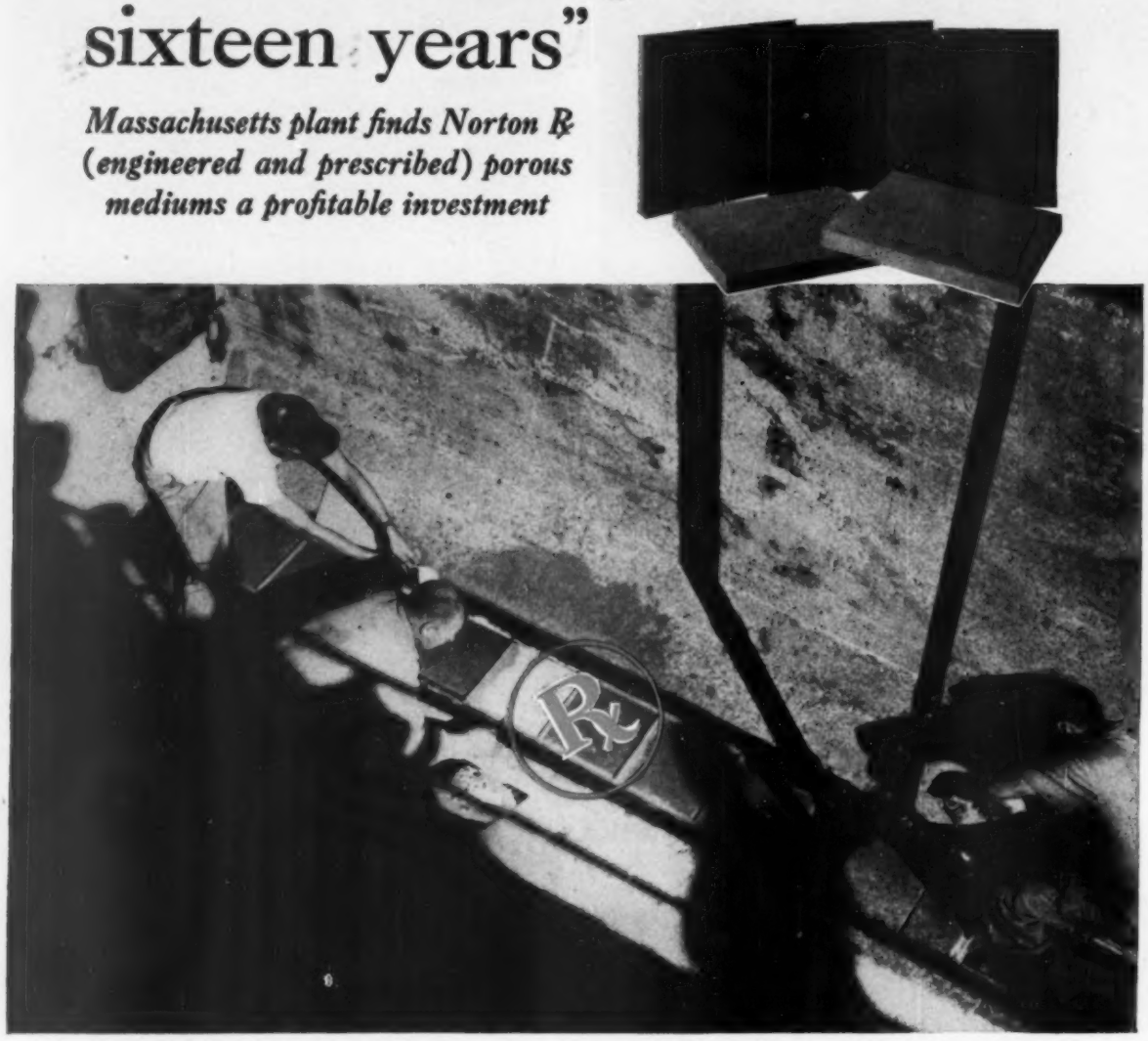
You can gain public support for your new sewage facilities by putting the new 1954 edition of CLEAN WATERS—G.E.'s "More Power to America" film—to work in your community. Premiered at the recent Federation of Sewage and Industrial Wastes Association convention at Cincinnati, this non-commercial, color movie is now available through your General Electric Apparatus Sales Representative.

Engineered Electrical Systems for Sewage Plants

GENERAL ELECTRIC

"Our Norton plates lasted sixteen years"

Massachusetts plant finds Norton Rx (engineered and prescribed) porous mediums a profitable investment



Ready For Many More Years Of Trouble-Free Service. Norton ALUNDUM* plates are replaced with new ones after 16 years of service in the Leominster, Mass., sewage disposal plant. Norton engineered and prescribed porous mediums supply money-saving Rx's for many important applications.

Selecting replacements for plates was no problem at this sewage plant. Like so many other users of Norton plates, they had ample proof — 16 years of it, in fact — of the outstanding efficiency and service life engineered into all Norton porous mediums.

Patented *controlled structure* processing of Norton ALUNDUM porous mediums assures even distribution of pores in sizes and open-pore ratios that make them the ideal Rx's for uniform diffusion. And Norton tubes bring you this uniform diffusion over their entire area, thanks to their seamless construction that also makes them much easier to clean.

Many Other Advantages

of Norton Rx porous mediums include exceptional resistance to breakage, chipping and to cleaning acids. You can get them in a wide range of sizes . . . tubes and discs for aeration in activated sludge treatment . . . tubes for diatomite filters in swimming pools . . . plates for rapid sand filters in water filtration.

Norton Can Supply You

with illustrated booklets, charts, tables and other helpful information on all porous medium applications. Ask your Norton Representative, or write to NORTON COMPANY, 231 New Bond St., Worcester 6, Massachusetts.

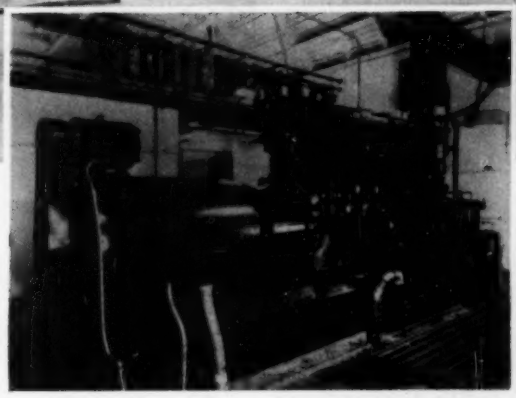
NORTON

POROUS MEDIUMS

Engineered... Rx... Prescribed

Making better products... to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries



This Model 40-S-8 Superior Diesel is rated at 435 hp at 900 rpm. It protects Attleboro's 24,000 citizens by being ready to supply their water needs, including fire protection, for long periods of time.

Power failure no longer threatens Attleboro's water supply

Not long ago, frequent power failures stopped vital city water pumping in Attleboro, Mass. Experiencing five or six such failures per year, city officials acted to assure the community a continuous water supply. They installed a generator set powered by a heavy-duty Superior Diesel model 40-S-8 to provide power during such failures.

As Mr. Russel F. Tennant, Supt. of Public Works, stated . . . they needed an engine that would "stay in there and deliver!" It didn't take long to realize the value of their new Superior Diesel. When hurricane "Carol" hit Attleboro recently, causing a million dollars worth of damage, the central station power was lost almost immediately. Superior power went right into action.

For two full days this Superior carried the entire load for pumping and building lighting. Result: "All operating routine was carried through splendidly." In referring to this emergency situation Mr. Tennant said, ". . . we certainly are proud and of course relieved, to own this engine and generator of proven worth."

Whatever your power generation requirements, be sure you have all the facts on National Supply's complete line (4 to 1765 hp) of Superior, Atlas and Lister Diesels. Write or call Engine Division offices in Springfield, Ohio, or contact the nearest sales and service point listed below for complete information.

DIESEL DUAL FUEL GAS ATLAS Superior ENGINES DISTRIBUTOR OF Lister DIESELS IN U.S.A.

THE NATIONAL SUPPLY COMPANY

ENGINE DIVISION PLANT AND GENERAL OFFICES: SPRINGFIELD, OHIO

SALES AND SERVICE POINTS: Gloucester, Massachusetts • Houston, Texas • Fort Worth, Texas • San Diego, California Oakland, California • Terminal Island, California • Ketchikan, Alaska • Washington, D.C. • Chicago, Illinois • Portland, Oregon • Astoria, Oregon • Casper, Wyoming • St. Louis, Missouri • Halifax, Nova Scotia • Vancouver, B. C. • Park Rapids, Minnesota • New York, New York • Seattle, Washington • New Orleans, Louisiana • Pittsburgh, Pennsylvania

Question:

Can we get installation savings and performance too?

Answer:

Yes...with the new Ring-Tite Coupling

On this Utah job, snow, ice and difficult conditions caused no installation slowdown.

In this California installation, flexible Ring-Tite joints permitted easy conformance to curves.

Speeds assembly of Transite Pressure Pipe

In state after state, contractors are learning that Transite® Pressure Pipe and the new Ring-Tite® Coupling provide fast, sure pipe line assembly with tight, dependable joints . . . strength to assure lasting, trouble-free water mains through the years.

With Ring-Tite, installation costs less—assembly follows digger closely. Typical contractors' comments: "On entire job, trencher and backfiller seldom over 150 feet apart . . ." "Laid 6" Class 150 Ring-Tite at a rate of 5000 feet per 8 hours."

The design of the Ring-Tite Coupling permits quick, easy alignment. To assemble, rubber rings are simply popped into grooves. Then lubricated pipe ends slide in under rings smoothly, easily and surely.

Pipe ends stop positively—with ends automatically separated within coupling. This separation gives the line flexibility to withstand shock and vibration, relieves line stresses, permits conformance to curves. Installations can be completed under adverse weather, temperature or terrain conditions. No complicated equipment is required.

Transite Pressure Pipe and the Ring-Tite Coupling are made of asbestos and cement. Strong and durable, they cannot rust; are highly resistant to corrosion. Tested to A.W.W.A. specifications.

For the new Ring-Tite folder TR-142A—please write to Johns-Manville, Box 60, New York 16, N. Y.

JOHNS-MANVILLE PRODUCTS

Johns-Manville TRANSITE PRESSURE PIPE

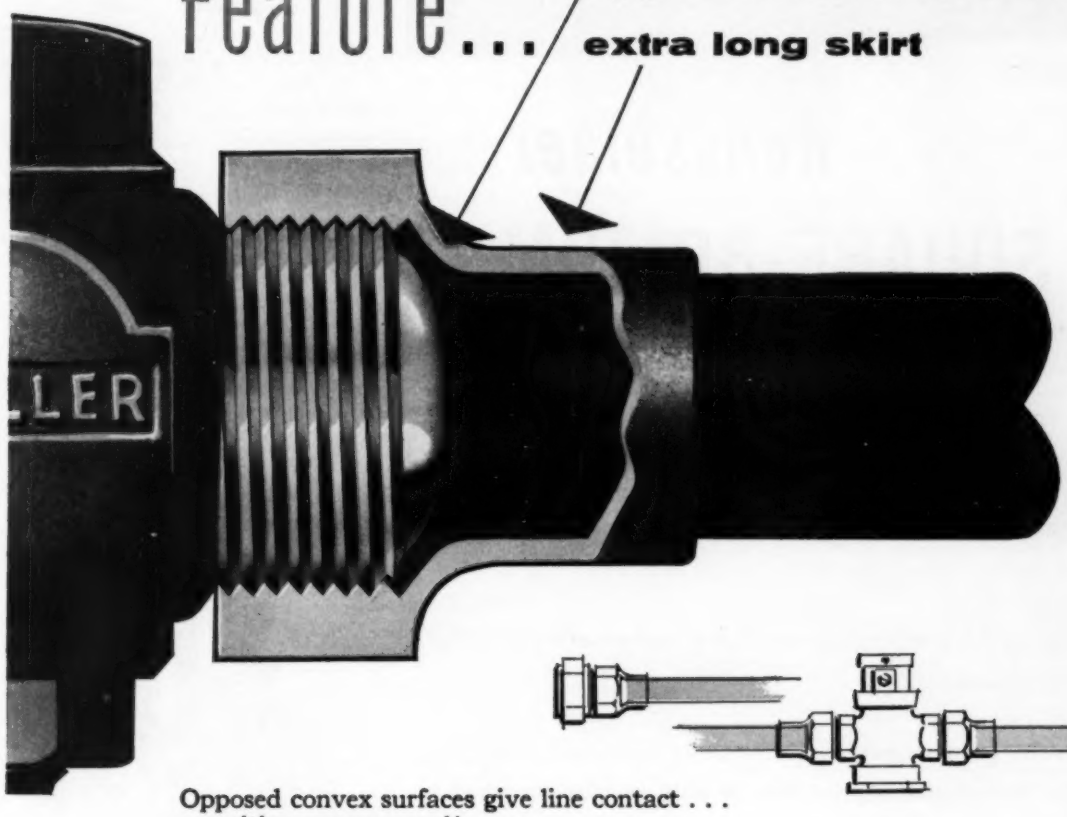
NOW WITH THE RING-TITE COUPLING

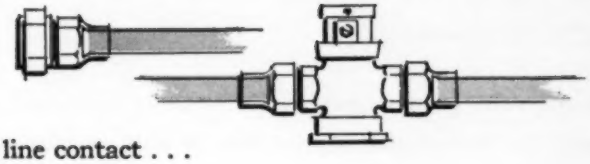
MUELLER®

COPPER CONNECTIONS

Feature . . . **opposed convex surfaces**

extra long skirt





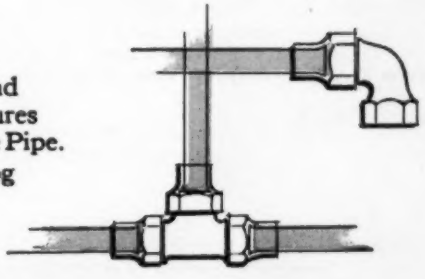
Opposed convex surfaces give line contact . . . a positive pressure seal!

Extra long skirt in tube nut gives the needed strength to the connection.

A full line of Corporation Stops, Curb Stops and Service Fittings with these and other plus features are available for use with Mueller Copper Service Pipe.

Consult your Mueller Representative or Catalog W-96 for full details.

Threads adopted as standard by AWWA



MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

Cleveland

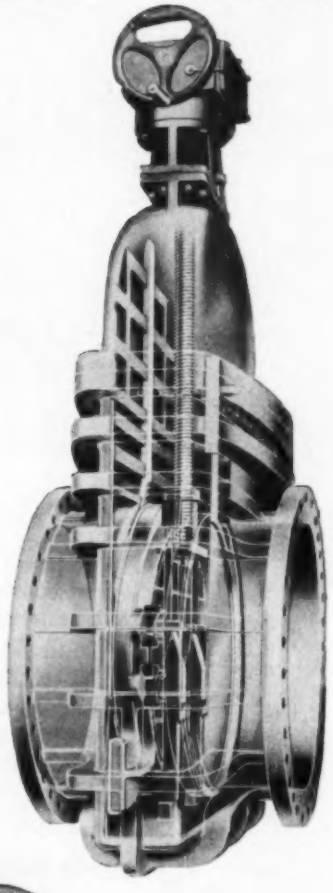
Kansas City

Indianapolis

FOR

Altitude Control	Intake Towers
Emergency Shut Off	Sewage Disposal
Frequent Operation	Throttling Service
Filtration Plants	Vertical Pipe Lines

Rensselaer SQUARE-BOTTOM GATE VALVES



This is the valve with the three point support throughout the entire length of gate travel, which eliminates any tendency of the down stream gate to tilt.

The seat ring and the gate ring do not come in contact with each other, except in fully closed position.

This is the valve used extensively for frequent operation, emergency shut-offs, for filter plants and for throttling. It may be furnished in both single and double square-bottom construction.

Made in sizes ranging from 4" to 54" and up to 250 W.P. Ask for Bulletin No. B.

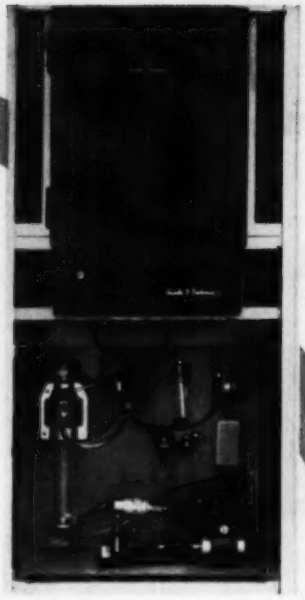
110

Rensselaer VALVE CO. TROY, N. Y.

GATE VALVES • FIRE HYDRANTS • SQUARE BOTTOM VALVES • CHECK VALVES • AIR RELEASE VALVES

SALES REPRESENTATIVES IN PRINCIPAL CITIES

NEW
Arnold O. Beckman
DISSOLVED OXYGEN ANALYZER
for continuous measurement!



- Continuous record
- Handles fluids, slurries, sludges, etc.
- Simple operation
- Highly accurate

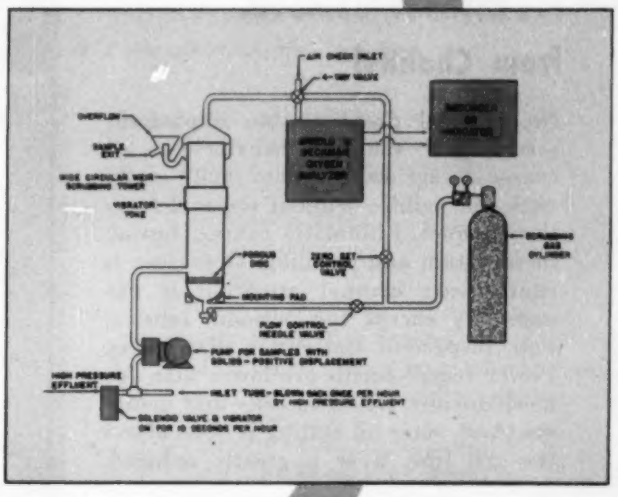
The accurate measurement of dissolved oxygen in fluid process streams is widely recognized as an important control factor in such municipal and industrial operations as sewage and water treatment . . . waste disposal . . . petro-chemical and chemical processes . . . food processes . . . and many others.

Now, you can make such measurements—continuously, simply and accurately—with the newly-developed Arnold O. Beckman Model 1A3B Dissolved Oxygen Analyzer!

- **The new Model 1A3B combines the field-proven Arnold O. Beckman paramagnetic principle of oxygen measurement with an improved method of stripping to provide a measurement specific for oxygen.**
- **The Model 1A3B is factory-calibrated to read in percent saturation so that efficiency of aeration or deaeration is shown directly. Or if preferred, the instrument can also be supplied to provide readings directly in parts-per-million.**
- **The Model 1A3B can be directly connected to any standard potentiometer-type recorder or indicator. No special accessory equipment is needed.**
- **Using the Model 1A3B is far superior—in speed, accuracy and convenience—to conventional chemical methods—and provides—immediately and continuously—the necessary control information for maintaining optimum processing uniformity.**

With a few variations the Model 1A3B can be adapted to a wide range of application requirements . . . to handling sludges and other liquids having high concentration of solids . . . to handling samples under abnormal pressures or temperatures . . . and to other difficult sampling conditions.

The Model 1A3B is a complete, compact unit—with the Analyzer in top compartment and the scrubbing unit below.


AIR CHECK INLET
4-WAY VALVE
OVERFLOW
SAMPLE EXIT
WIDE CIRCULAR WEIR SCRUBBING TOWER
VIBRATOR
POROUS DISC
ZERO SET CONTROL VALVE
MOUNTING PAD
FLOW CONTROL NEEDLE VALVE
PUMP FOR SAMPLES WITH SOLIDS - POSITIVE DISPLACEMENT
HIGH PRESSURE EFFLUENT
INLET TUBE - BLOWN BACK ONCE PER HOUR BY HIGH PRESSURE EFFLUENT
SOLENOID VALVE & VIBRATOR ON FOR 10 SECONDS PER HOUR

The Principle is simple and positive. The constantly-fresh test sample in scrubbing tower is stripped of dissolved oxygen by inert scrubbing gas—and result measured by Analyzer. Measurement is continuous and accurate!

RANGES—from a maximum of 0-100% O_2 saturation to a minimum of 0-5 ppm, full scale. Intermediate ranges are also available.

Arnold O. Beckman INC.
1020 MISSION STREET, SOUTH PASADENA, CALIFORNIA

Get the full story *on this new Arnold O. Beckman development by writing directly for information on the Model 1A3B Dissolved Oxygen Analyzer. Ask for Data File # 13R-124.*

NOW - A Teammate for the COMMINUTOR

THE BARMINUTOR

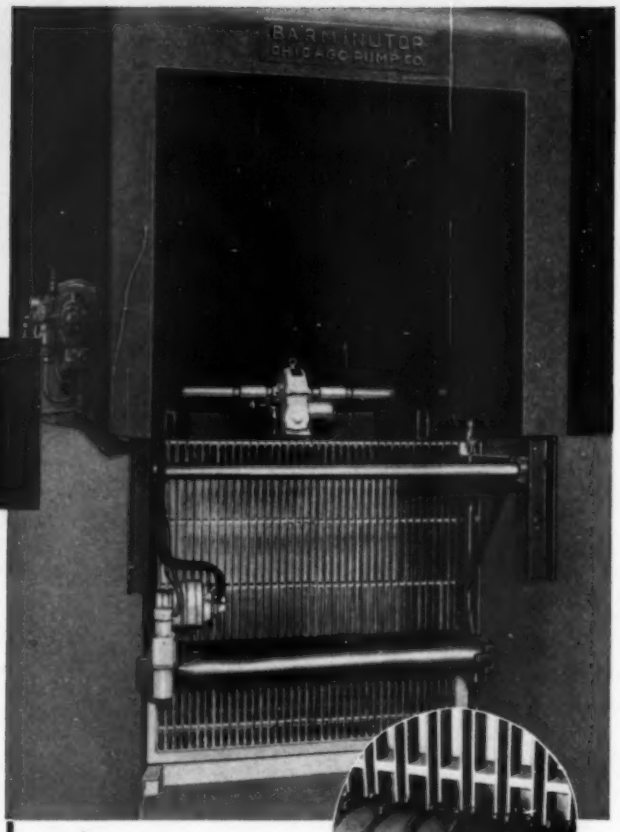
Gives Same Clean, Continuous Disposal of Coarse Sewage Matter ...without Removal from Channel

No disposal problems, no unpleasant servicing — the BARMINUTOR cuts all coarse sewage material into small, easily settleable solids—without removal from the channel. Eliminates raking, burial, incineration and grinding. Operation is continuous; manual attention is unnecessary except for periodic lubrication, inspection and cutter sharpening. Power requirements are lower than for mechanically raked screens and grinders. And, since all cutting is done above the grit line, wear is greatly reduced.

IDEAL FOR TREATMENT PLANTS, PUMPING STATIONS, OUT-FALL SEWERS

The BARMINUTOR can be used in already established influent channels from one to twelve feet wide. No special basin or channel shape is required. Descriptive literature and engineering data is available on request.

VISIT OUR BOOTH at the F. S. I. W. A. Convention, Oct. 11 - 14, 1954. Netherlands Plaza Hotel, Cincinnati, Ohio.



Model A. BARMINUTOR for handling larger flows economically.

Close-up of cutters and combs. Cutters rotate within slots of both bar and comb.

EFFICIENCY PROVED

More Than 4000 COMMINUTORS Installed since their development by the Chicago Pump Company 19 years ago stand behind the BARMINUTOR. More than five years of actual operation preceded the installation of BARMINUTORS at a number of modern treatment plants. At the Indianapolis, Indiana Sewage Plant, a BARMINUTOR was subjected to test loads of screenings up to six times the normal 40 M.G.D. load. Comminution time: 6 minutes. Head loss: not in excess of 6".

CHICAGO PUMP COMPANY

SEWAGE EQUIPMENT DIVISION

622 DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

Flush Bloom, Screw-Follow, Plunger Horizontal and Vertical Non-Clog Water Seal Pumping Units, Samplers

Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Comminutors.

now...low cost quality water for smaller users

HIGH QUALITY WATER ★ LOW INSTALLATION COST ★ MINIMUM OPERATING ATTENTION

ACCELAPAK (Trade Mark) water plant is the answer

"ACCELAPAK" equipment makes "custom plant" water quality available with "standard package" convenience and economy for . . .

- Small communities
- Camps and resorts
- Estates
- Industrial plants, etc.

"ACCELAPAK" Water Plant includes:

- ACCELATOR® clarifier or softener
- Slurry feeder for pulverized limestone or hydrated lime
- NEUSOL® feeder for coagulant (and hypochlorite when needed)
- Filter – gravity or pressure
- Other components as required

Capacities: 15 g.p.m. to 250 g.p.m. and up

▶ *for full details* on how the "ACCELAPAK" plant can provide you with high quality water, treated at a cost well within the budget, send this coupon now.

INFILCO INC.

Tucson, Arizona

Plants in Chicago and Joliet, Illinois

Field offices in 33 principal cities in the U. S., Canada and Mexico

INFILCO Inc., P.O. Box 5033, Tucson, Arizona

☐ Please send me Bulletin 1870E

☐ Please have an INFILCO representative contact me regarding "ACCELAPAK" treating equipment.

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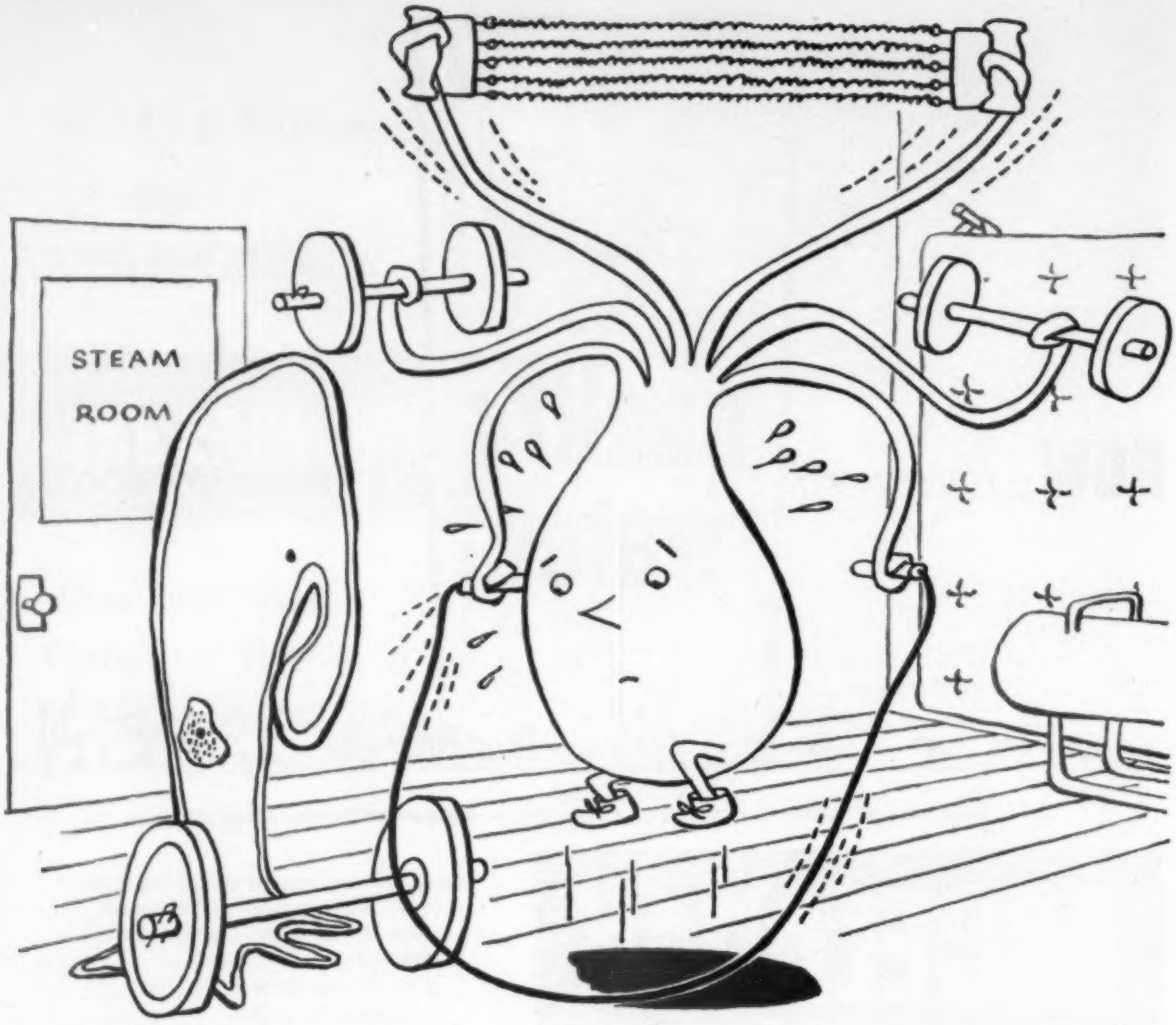
CITY_____ ZONE____ STATE_____



"It's no use, Orgie, we can't condition ourselves against PITTCHLOR®"

Truer words were never spoken. Chlorine-susceptible bacteria and algae succumb instantly to the germ-killing powers of Pittchlor.

A high-test calcium hypochlorite containing a minimum of 70% available chlorine, Pittchlor works fast and effectively in chlorinating water supplies, treating sewage, or wherever the germicidal and deodorizing action of chlorine is needed.

Pittchlor is dry, white and free-flowing. Its granular form permits ease of application either manually or by mechanical feeders. Write for free folder.

FOR
WATER PURIFICATION
SEWAGE TREATMENT
SWIMMING POOL
SANITATION

Stocked by leading jobbers in 5 lb. resealable cans (9 per case), 3¾ lb. cans (12 per case) and 100 lb. and 130 lb. drums.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION
SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY
ONE GATEWAY CENTER · PITTSBURGH 22 · PENNSYLVANIA

DISTRICT OFFICES: Cincinnati • Charlotte
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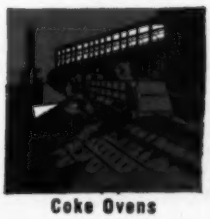
Quality control begins with our own sources of raw materials

In the production of cast iron pressure pipe, the advantages of an integrated operation, including direct control and ownership of raw materials sources, are important. They mean complete independence of action in product research and development throughout every step in the production of raw materials—*mining* operations (coal and iron ore)—*quarrying* operations (limestone)—*coking* and *blast furnace* operations—for producing pig iron.

In addition to being able to control the quality of pipe-making raw materials at their sources, our Quality Control of pipe production gives further assurance to customers that the quality level of U. S. Cast Iron Pipe is in excess of standard specifications. Our pipe is produced to our own quality control specifications, more exacting than the established specifications under which cast iron pipe is normally purchased.

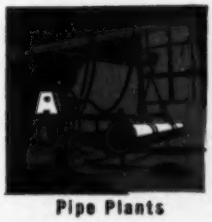
U.S. CAST IRON PIPE

Ore and Coal Mines



Coke Ovens

Blast Furnaces



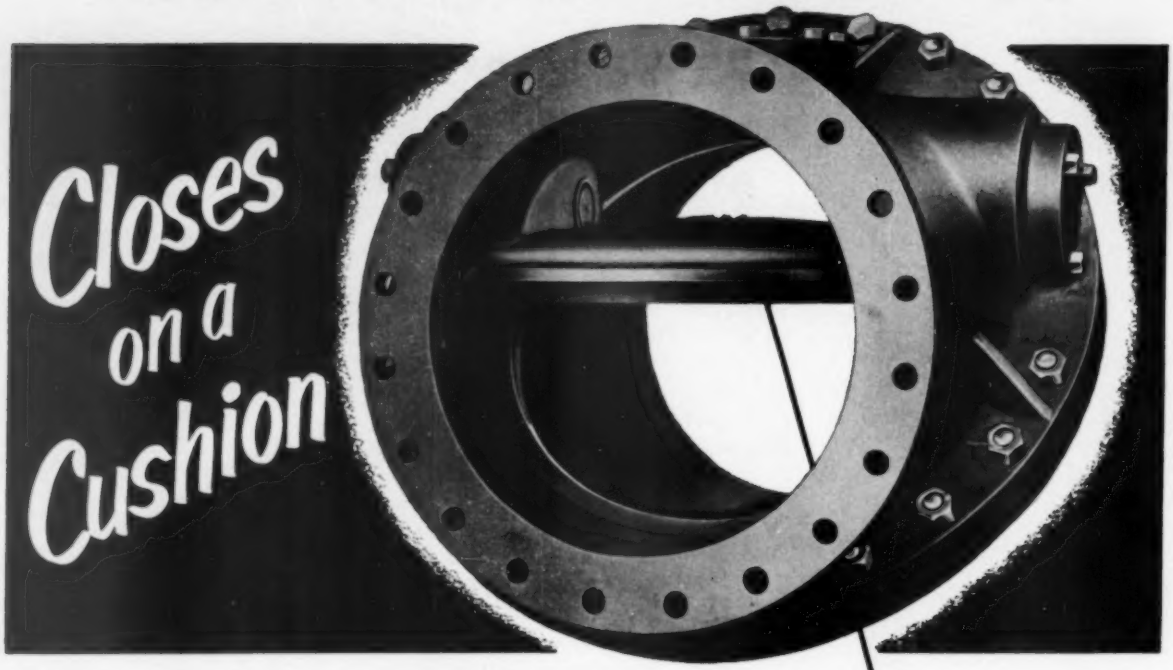
Pipe Plants

U. S. PIPE & FOUNDRY COMPANY

GENERAL OFFICES: BIRMINGHAM 2, ALABAMA

A wholly integrated producer . . . from mines and blast furnaces to finished pipe.

Chapman's Tilting Disc Check Valve

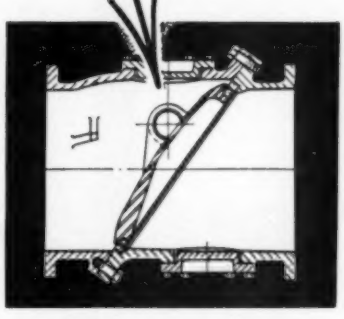


...for low cost, slam-free operation

Balanced pressures *cushion* the movement of the disc in Chapman's Tilting Disc Check Valve. The valve closes quickly but quietly, in all but unusual piping arrangements. There's no slamming to damage pipe-line joints or the valve itself. And *drop-tight* closure eliminates sliding wear on the disc and seat.

In the open position, the "airfoil" designed disc rides firmly against stops, without swinging or fluttering. That's why the hardened extra-large hinge pins give extremely long wear. And the absence of turbulence is one reason why head loss through Chapman's Tilting Disc Check Valve is lower than through any other type of check valve.

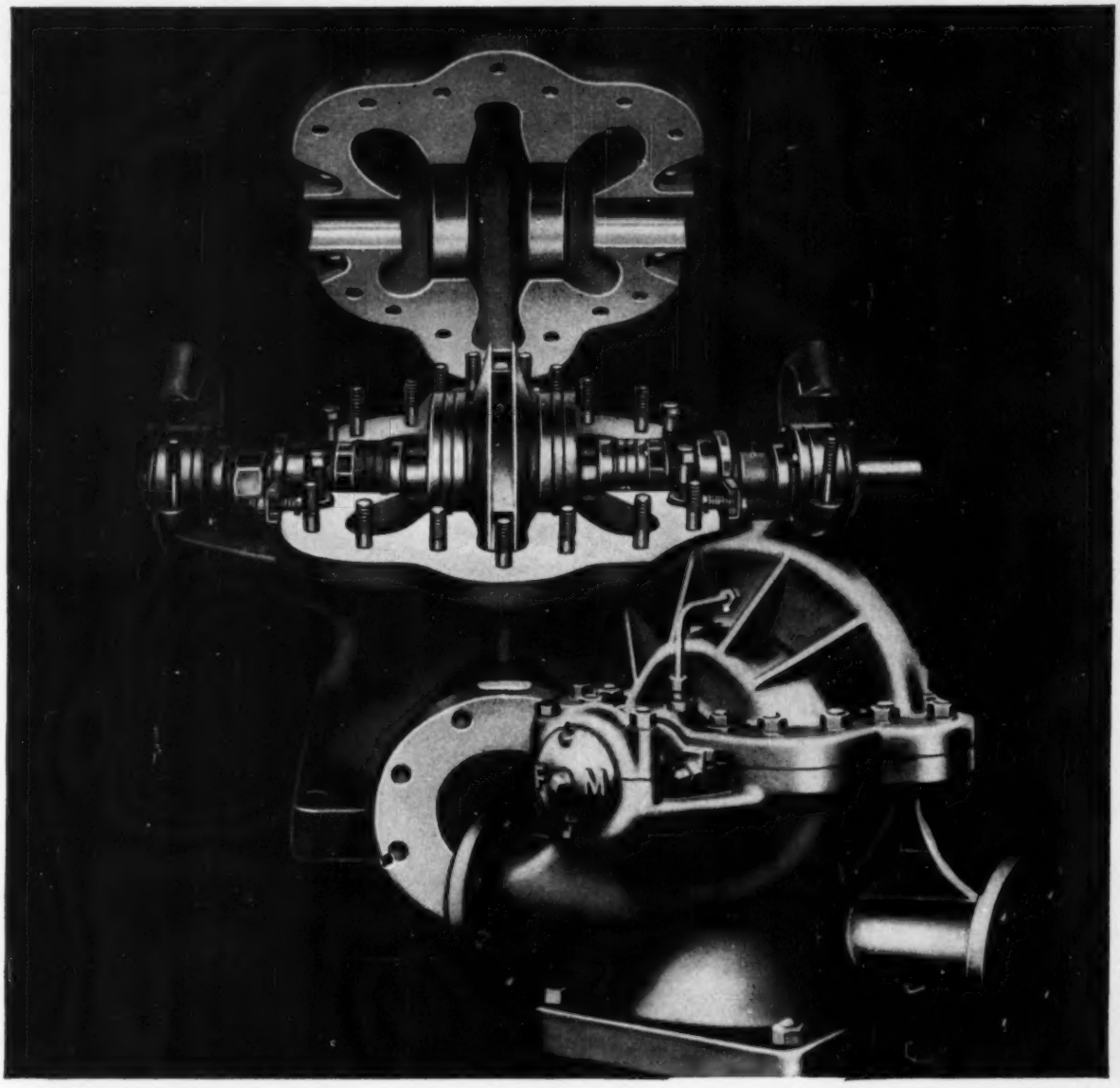
Low head loss, increased wear resistance and freedom from destructive slamming make Chapman's Tilting Disc Check Valves unbeatable for almost every installation. Write for Catalog No. 30 today.



Here's why
CHAPMAN Tilting Disc Check Valves *Keep Quiet* All Their Lives

This specially designed "airfoil" disc balances perfectly in open position . . . then drops easily to closed position (cushioned by the flow). No jarring or slamming, in usual pipe-layouts. Write for bulletin.

THE CHAPMAN VALVE MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS



out of the mouth of a pump...

Suppose a pump could "spill its works" . . . tell you how it was made . . . speak of the design, material, workmanship that went into its being . . . then you could know . . . and buy with confidence.

Because after all, pumps do look very much alike. How, then, to tell which make is best for you. *Reputation* is one way, *performance* another.

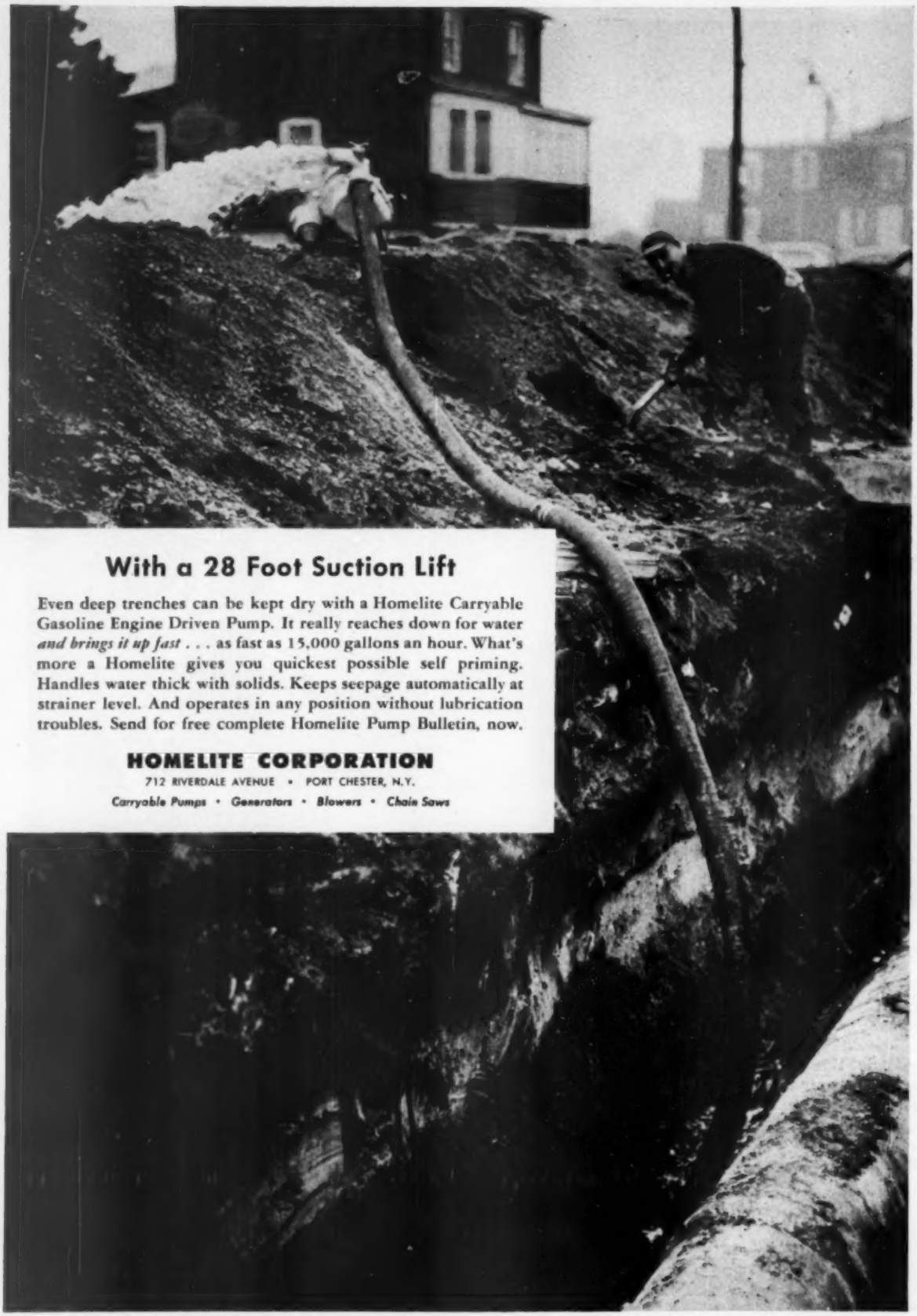
And, on both counts, Fairbanks-Morse pumps stand out. Don't take our word for it. Check with Fairbanks-Morse users. We'll stand by their verdict. For Fairbanks-Morse has only one standard . . . *quality* . . . the quality that means dependability, service, low maintenance, all those important points that you want in the pumps you buy.

To get these advantages in your pumps, rely on the world's largest manufacturer of a complete pump line. See your nearest Fairbanks-Morse Branch, pump dealer, or write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

FAIRBANKS-MORSE

a name worth remembering when you want the best

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS



With a 28 Foot Suction Lift

Even deep trenches can be kept dry with a Homelite Carryable Gasoline Engine Driven Pump. It really reaches down for water *and brings it up fast* . . . as fast as 15,000 gallons an hour. What's more a Homelite gives you quickest possible self priming. Handles water thick with solids. Keeps seepage automatically at strainer level. And operates in any position without lubrication troubles. Send for free complete Homelite Pump Bulletin, now.

HOMELITE CORPORATION

712 RIVERDALE AVENUE • PORT CHESTER, N.Y.

Carryable Pumps • Generators • Blowers • Chain Saws

Vinyl coating users agree . . .

YOU GET

MORE MILS PER GALLON WITH AMERCOAT 33

Amercoat's higher solids content gives you a thicker, heavier coating—more mils for every gallon applied.

THIS MEANS YOU SAVE MONEY TWO WAYS ON MAINTENANCE PAINTING

Lower Material Cost. You save on material because it takes fewer coats of AMERCOAT 33 to build the required film thickness.

Lower Labor Cost. You save on labor because fewer coats mean fewer man hours for application—less down time, too.

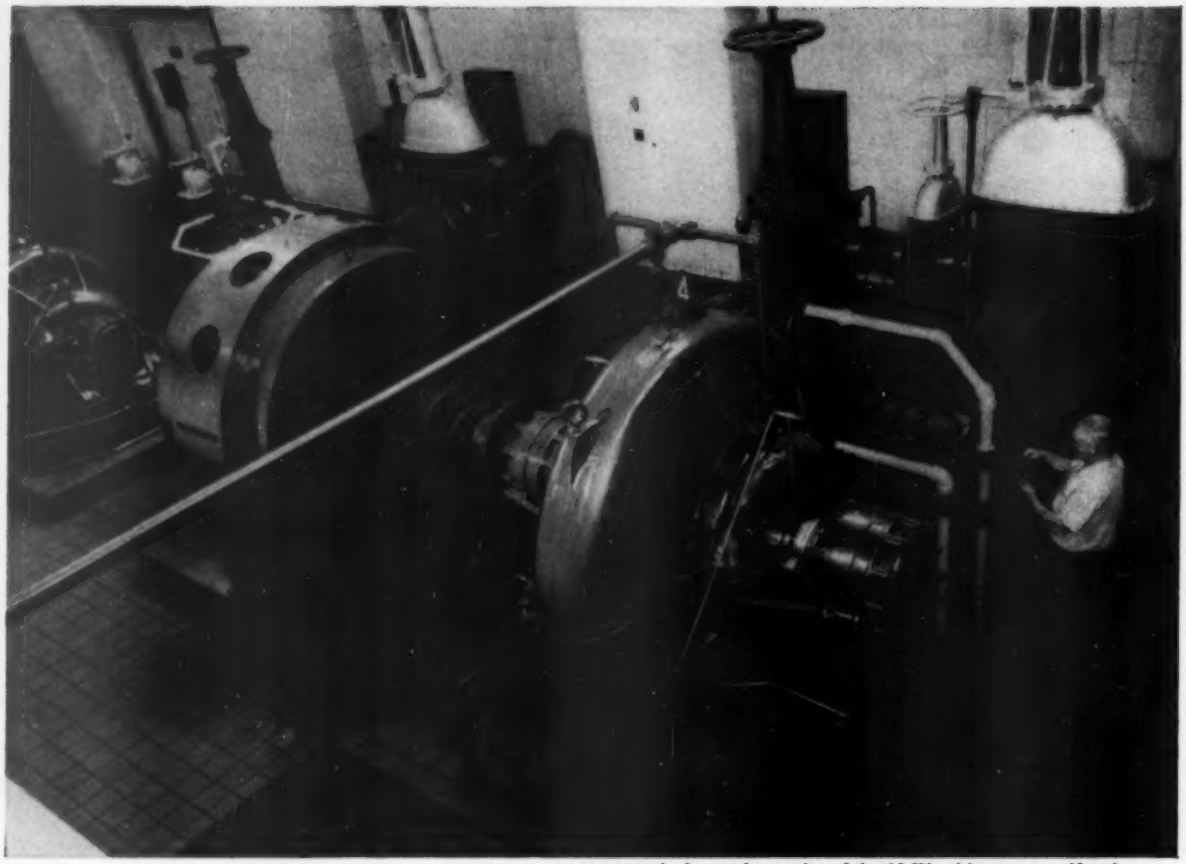
In addition to more mil thickness per gallon, you get more protection per gallon. AMERCOAT 33 is formulated specifically for maximum chemical resistance and for severe weathering conditions. In major industries from coast to coast — chemical, petroleum, pulp and paper, food, and many others — maintenance engineers look to AMERCOAT 33 for low cost, long lasting protection for all types of steel or concrete structures.

Amercoat pioneered the development of protective coatings especially designed for severe corrosion problems. Today it is the only organization that offers you... a complete line of corrosion resistant coatings...nationwide distribution... trained technical men to give you on-the-job assistance throughout the United States and Canada.

Amercoat CORPORATION
Dept. P,
4809 Firestone Blvd.,
South Gate, California

CHICAGO, ILL. • KENILWORTH, N. J. • JACKSONVILLE, FLA. • HOUSTON, TEX.

Write today for the AMERCOAT 33 Technical Bulletin which gives a complete description of the coating's chemical and physical properties.



215 MGD is the total capacity of the 10 Worthington centrifugal pumps on the job in Philadelphia's modern Torresdale Station.

Philadelphia's newest pumping station has 10 Worthington centrifugals

Back in 1800 Philadelphians got along on 700,000 gallons of water a day.

It was pumped through 35 miles of wooden pipes from America's first municipally owned pumping station, located where City Hall now stands.

Today the city's water system has reached the point where just one of its 16 pumping stations — the modern Torresdale Station — can pump 215 million gallons of water a day into the 70-square-mile area it serves. That gallonage is the capacity of Torresdale's 10 electric-motor-driven Worthington centrifugal pumps which range in horsepower from 250 to 1750.

This is one more example of the tough assignments handed to Worthington water works equipment these days by municipalities on all sides. Whether the need is for pumps, comminutors, Diesels or turbines, there's a Worthington unit with design and construction features tested on a thousand jobs. There's more to be said, of course, and it's all in Bulletin WP-1099-B60. Write for it to Worthington Corporation, Public Works Division, Harrison, New Jersey, or get in touch with your nearest Worthington district office. W.4.2

WORTHINGTON

ALL MAJOR PUBLIC WORKS EQUIPMENT UNDER ONE RESPONSIBILITY

Water Works Pumps • Sewage Pumps • Comminutors • Vertical Turbine Pumps • Vacuum Pumps

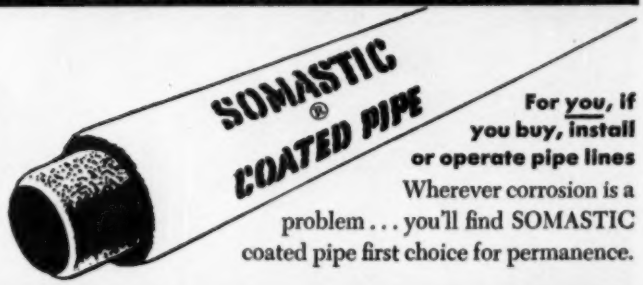
ONE gives you THREE!

source of supply — **pipe line processes**

TATE · CENTRILINE · SOMASTIC · TATE · CENTRILINE · SOMASTIC · TATE

1 SOMASTIC® PIPE COATING

Pipe Linings, Inc. manufactures and applies the world-famous and proven SOMASTIC Pipe Coating for exterior protection against corrosion in the 11 Western States and All Foreign Locations.



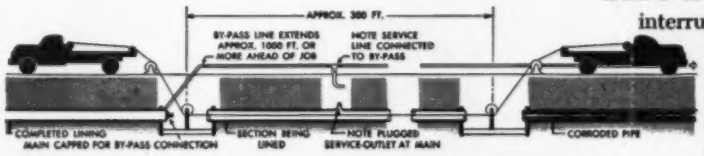
For you, if you buy, install or operate pipe lines

Wherever corrosion is a problem . . . you'll find SOMASTIC coated pipe first choice for permanence.

TATE · CENTRILINE · SOMASTIC · TATE · CENTRILINE · SOMASTIC · TATE

2

THE TATE PROCESS, applicable to water, oil and gas pipe lines, renews old iron and steel pipe "in place" as shown here in the schematic drawing. The Tate Process is used for pipe lines from 4" to 16" in diameter. Only momentary interruption to service is necessary while by-pass sections are installed.


APPROX. 300 FT.
BY-PASS LINE EXTENDS APPROX. 1000 FT. OR MORE AHEAD OF JOB
NOTE SERVICE LINE CONNECTED TO BY-PASS
COMPLETED LINING MAIN CAPPED FOR BY-PASS CONNECTION
SECTION BEING LINED
NOTE PLUGGED SERVICE-OUTLET AT MAIN
CORRODED PIPE

TATE · CENTRILINE · SOMASTIC · TATE · CENTRILIN

3

THE CENTRILINE PROCESS is used for lining 16" to 144" pipe lines "in place." Cost is much less than the cost of installing new pipe. Premixed cement-mortar is thrown by centrifugal force, at uniform high velocity, against the inside surface of the pipe, and then mechanically troweled to a smooth, even finish. Centrilining is applicable to fresh or salt water, oil, sewage, gas or industrial waste lines, sewers and drains.

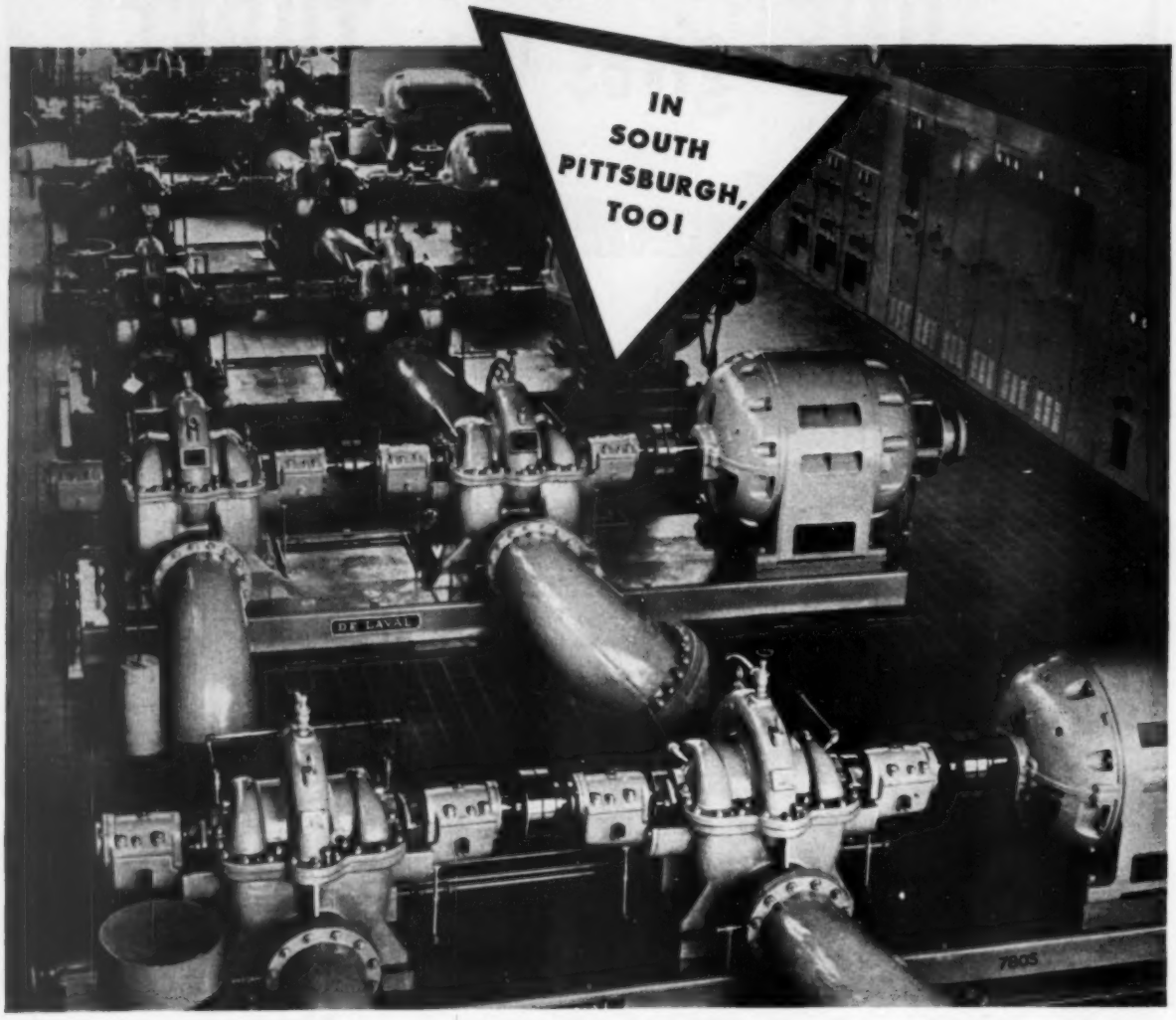
You Get These Advantages From Cement Mortar Lining!

- New pipe performance
- Prevents leakage
- Restores full flow coefficients
- Reduces pumping and maintenance costs
- Protects against corrosion, contamination and discoloration at much less than the cost of installing new pipe!

Complete mobile equipment and expert crews are available to bring new efficiency to your old pipe. A Pipe Linings, Inc. hydraulic engineer will be glad to discuss your problem. No obligation!

PIPE LININGS, INC.

DE LAVAL pumps America's water...



These five De Laval centrifugal pumping units, each consisting of two pumps in series, are installed in the Hays Mine Station of the South Pittsburgh Water Company. The unit in the foreground is designed for 5,400 gpm against a total head of 395 ft. at 1,200 rpm and is driven by a 600 hp motor. The other four units are identical, each designed for 9,000 gpm against a total head of 395 ft. at 1,200 rpm, and are each driven by a 1,000 hp motor.

More than 80% of America's cities depend on De Laval pumps to meet their water needs efficiently and economically. De Laval municipal pumping units range in capacity from 100 thousand to 100 million gallons per day.

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DE LAVAL STEAM TURBINE COMPANY

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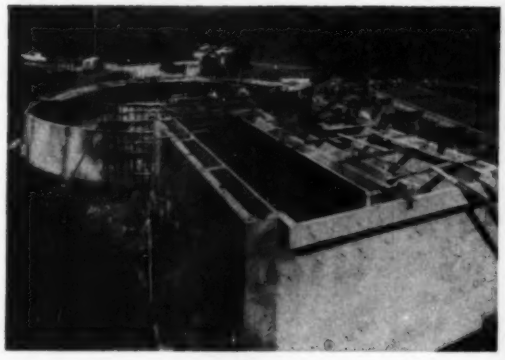

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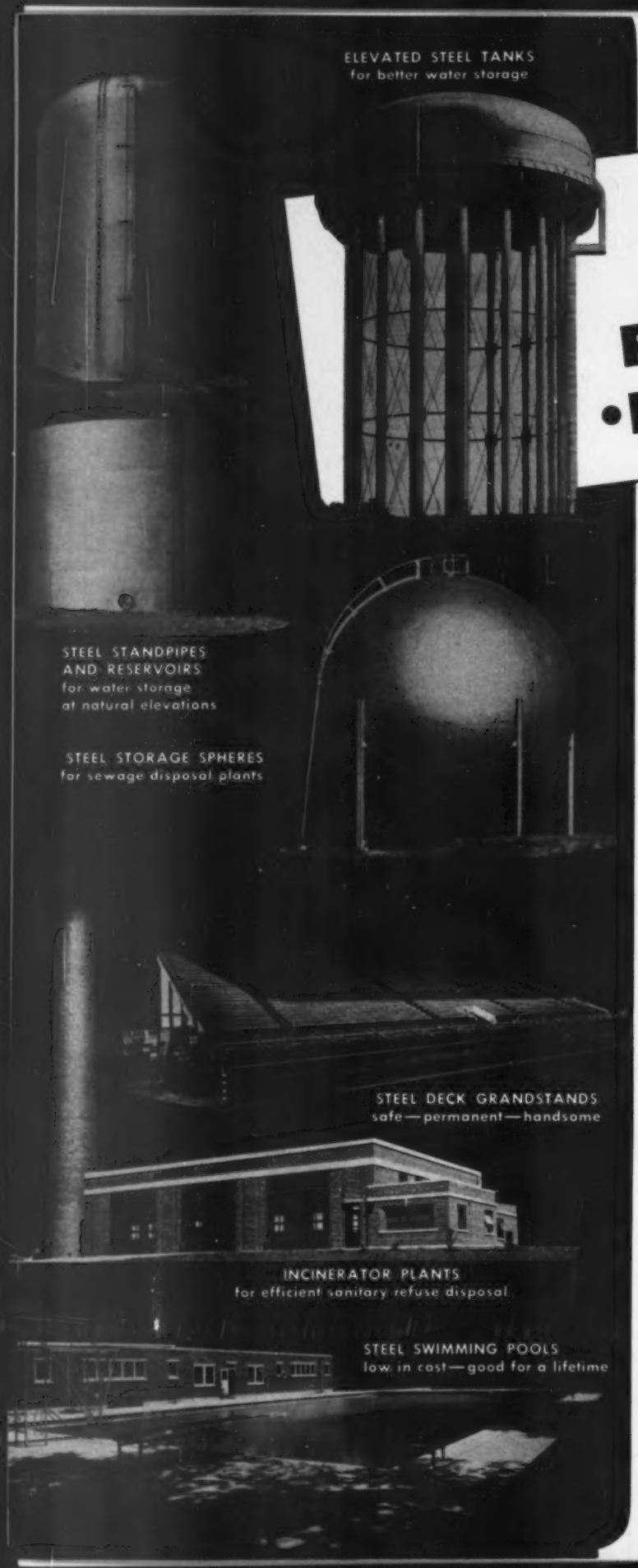

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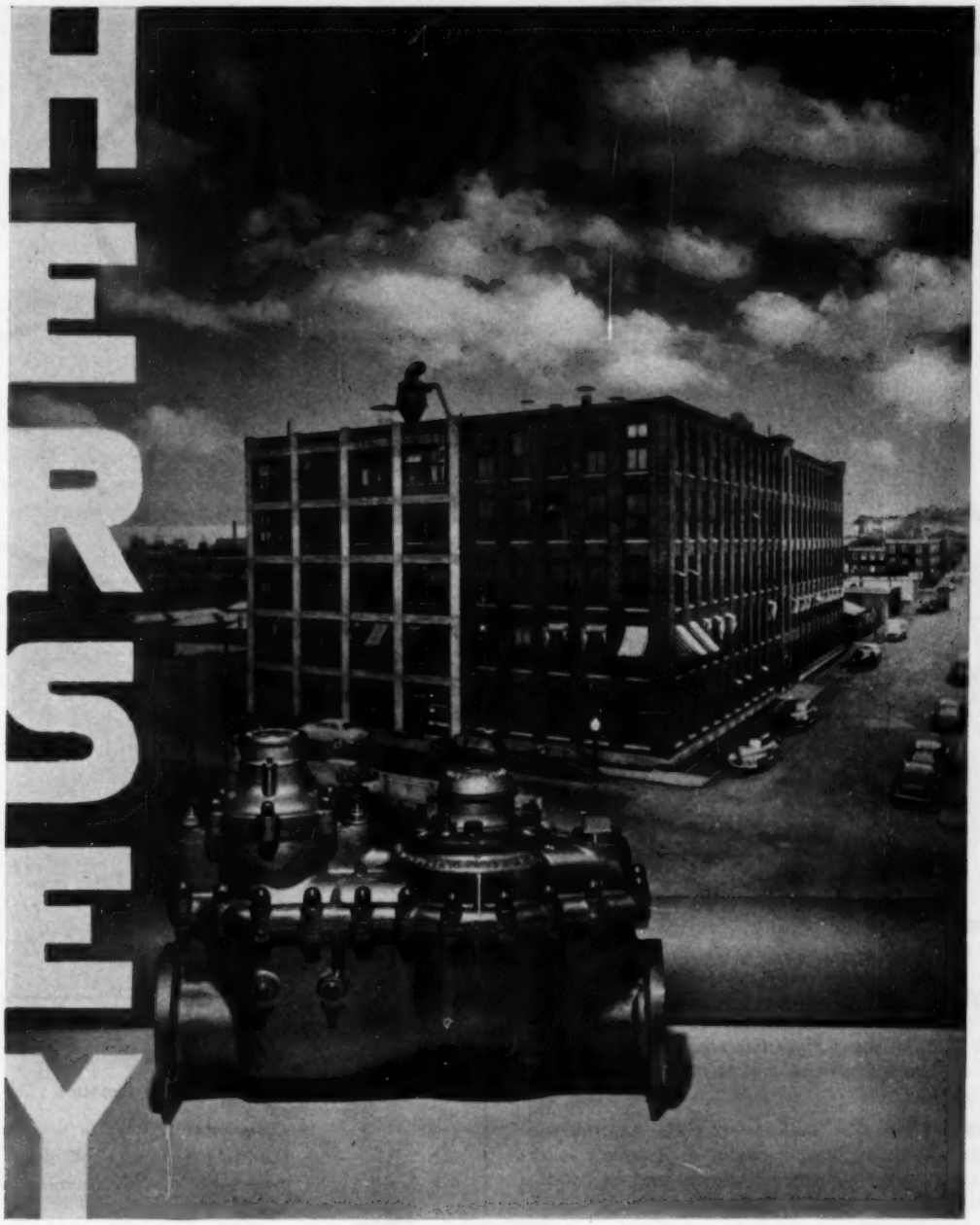

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All bronze case from 2" to 6"

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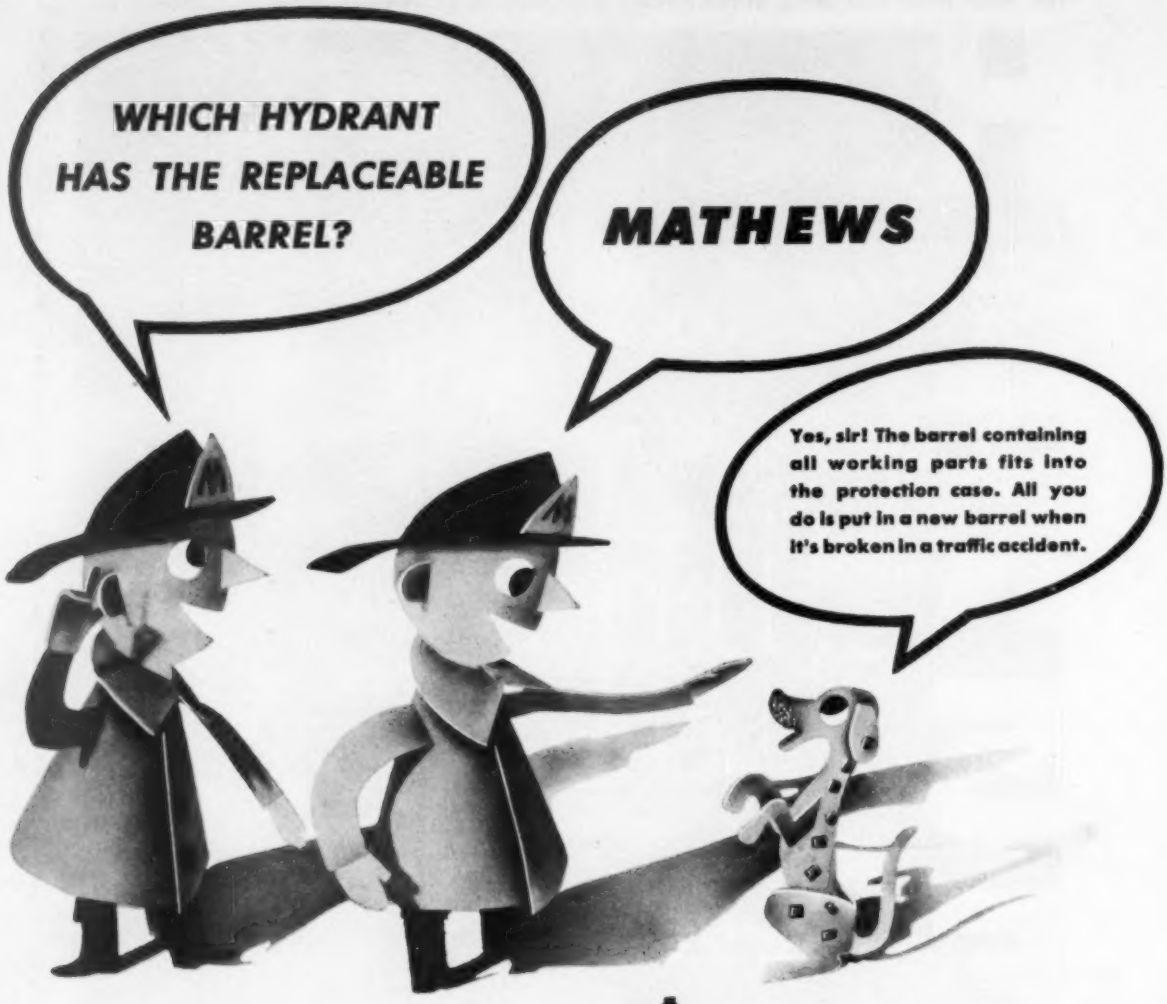
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BADGER
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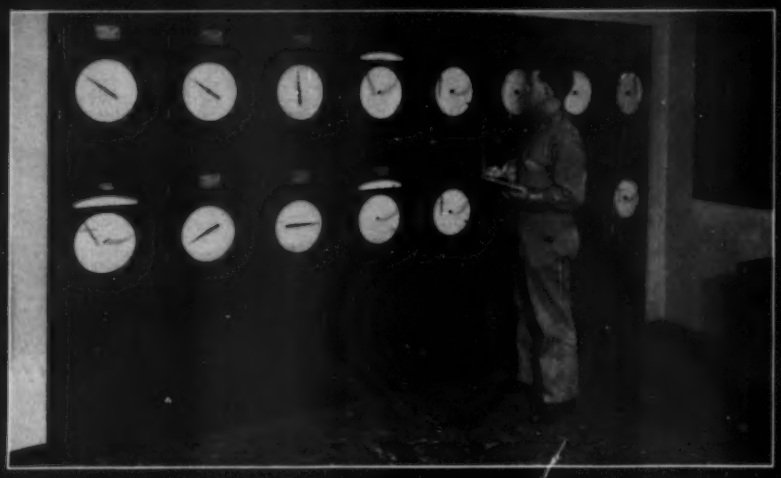
"Measures the water of the world"

Main panelboard in the General Office. These Builders and Omega instruments meter: raw water flow, settled water flow, high service pump flows and pressures, clearwell level, wash water tank level . . . feed rates of soda ash, lime, alum . . . also slaker temperature. Extensive use of remote metering instrumentation has resulted in a plant which is unusually economical to operate.



Filter operating gallery showing attractive operating tables with Builders Loss-of-Head and Rate-of-Flow Gauges. These Gauges and the Builders Filter Effluent Controllers insure convenient and efficient filter operation. A Builders 24" dial indicator shows at a glance wash water flow rate.

Section of chemical feeder room showing three of the Omega Belt Gravimetric Feeders. The two soda ash feeders at the left include properly sized dissolving chambers. The right hand unit consists of an Omega Belt Gravimetric Feeder with Omega Lime Slaker for continuous feeding and slaking of quicklime. The performance of all Omega Feeders is charted on instruments on the main panelboard (see photo above).

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City Water Works

(COMPLETED IN 1952)

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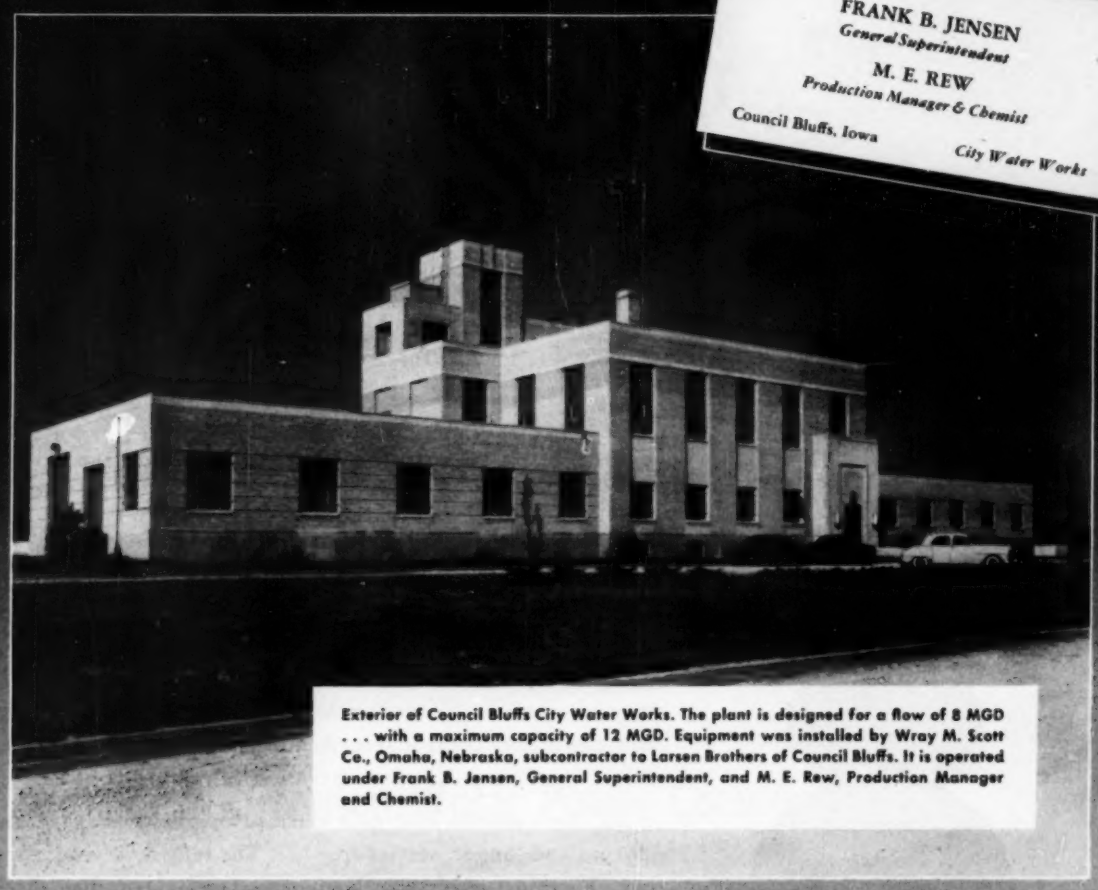
CONSULTING AND DESIGNING ENGINEERS
KANSAS CITY, MO.

FRANK B. JENSEN
General Superintendent
M. E. REW
Production Manager & Chemist
Council Bluffs, Iowa — *City Water Works*

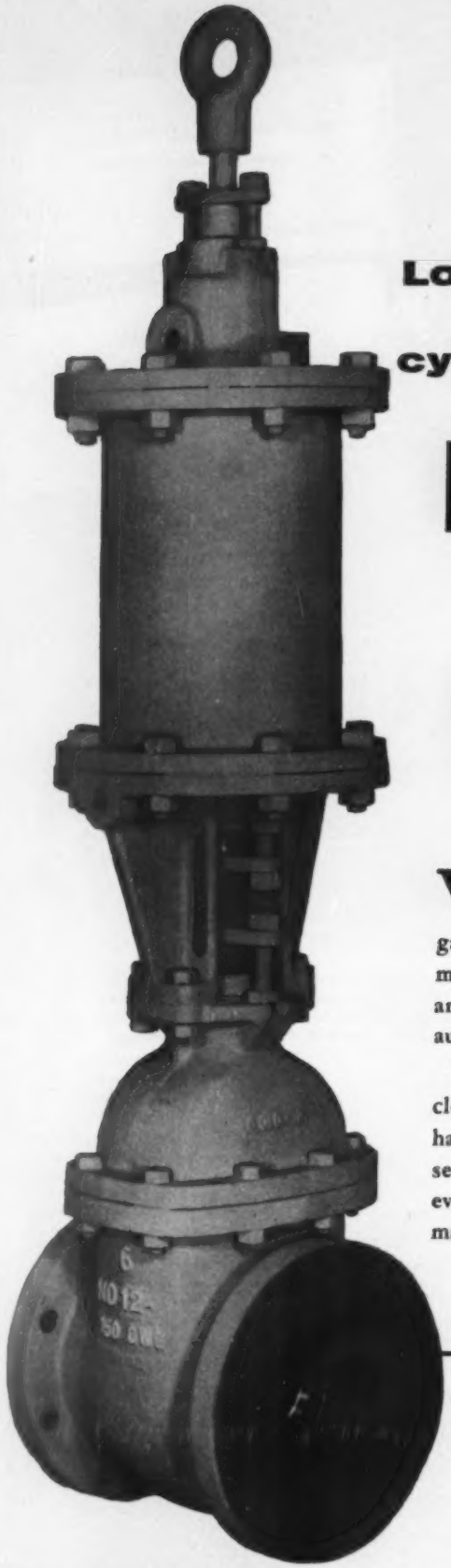


Exterior of Council Bluffs City Water Works. The plant is designed for a flow of 8 MGD . . . with a maximum capacity of 12 MGD. Equipment was installed by Wray M. Scott Co., Omaha, Nebraska, subcontractor to Larsen Brothers of Council Bluffs. It is operated under Frank B. Jensen, General Superintendent, and M. E. Rew, Production Manager and Chemist.

With the construction of this attractive, functional water works, Council Bluffs has made a complete break with the past. The new plant was placed in service in August 1952, replacing divergent facilities some of which dated back as far as 1881. It now assures the industries, railroads, and approximately 45,000 residents of Council Bluffs of an adequate supply of high quality, softened water.

Every element of this plant has been designed to promote high accuracy of control and convenient, low cost operation. Extensive use is made of remote metering and controlling equipment for centralized supervision of flows, liquid levels, pressures, and chemical feed rates. Builders-Providence takes pride in the fact that its metering and controlling equipment was selected for this thoroughly modern water works.

For complete information describing Builders Water Works Equipment supplied for the Council Bluffs plant, address **Builders-Providence, Inc., Providence, Rhode Island.**



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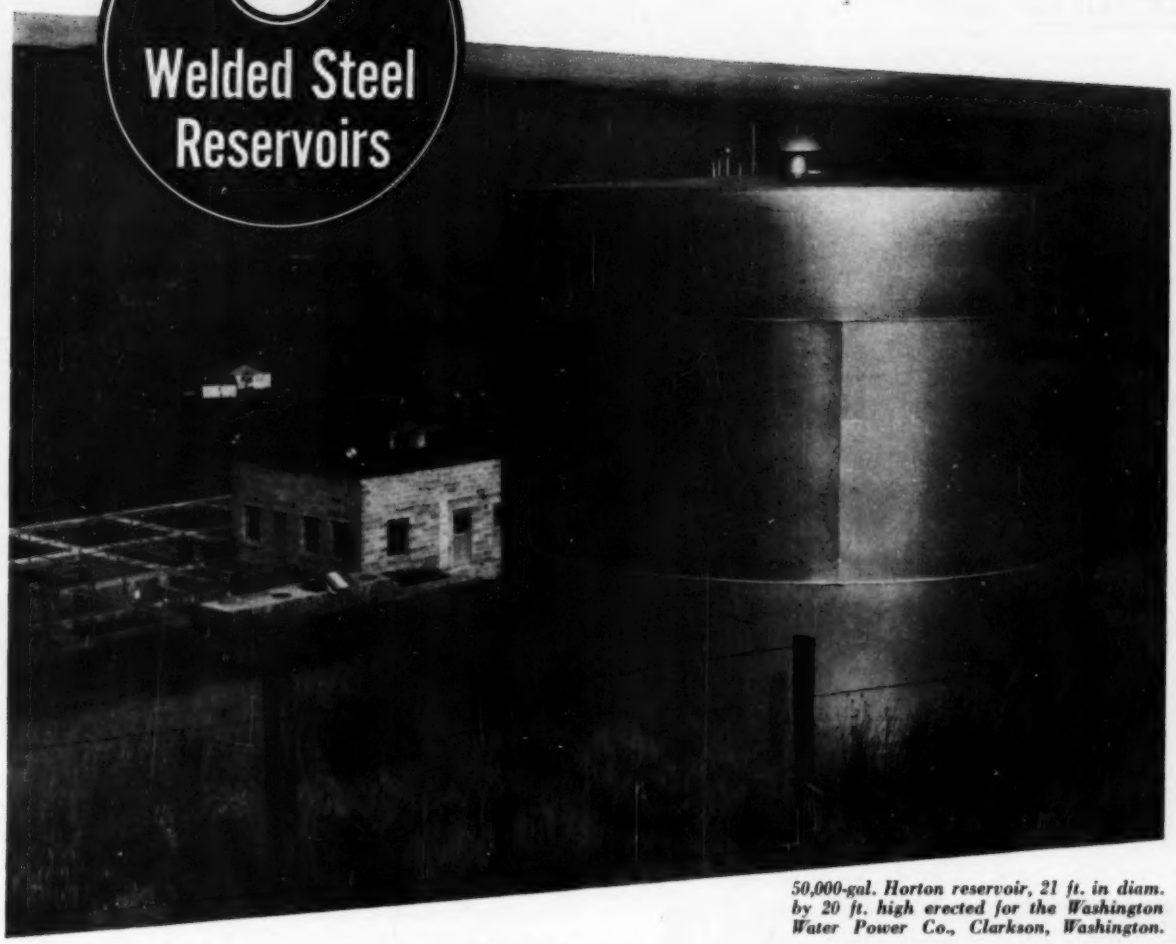
Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

Welded Steel Reservoirs



50,000-gal. Horton reservoir, 21 ft. in diam. by 20 ft. high erected for the Washington Water Power Co., Clarkson, Washington.

. . . for Washington Water Power Company

Shown above is one of two Horton® reservoirs recently installed for municipal water service by Washington Water Power Company at Clarkson, Washington. Where terrain permits location atop a hill or on a natural elevation, Horton reservoirs often provide the most efficient and economical type of storage for municipal water service.

Write our nearest office for estimates or quotations on a Horton reservoir, elevated water tank or Watersphere®. CB&I engineers will be happy to assist in choosing the structure best suited to your particular needs. There will be no obligation on your part.

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SPEAKING OF COSTS

Engineered by the New Orleans Sewerage and Water Board and installed by the Boh Brothers Construction Company, this 5-mile steel force main serves 15,000 suburban residents. After being laid in the trench by side boom bulldozer, the 30-inch pipe was Dresser-Coupled by 2-man crews averaging only 20 minutes per joint. Six hundred feet of main crossed the Industrial Canal. The pipe was first joined, then floated out and sunk into a dredged channel 50 feet below the surface. Navigation was interrupted for only two days.

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Following installation of Dresser Couplings and Dresser Bonds, the bituminous-coated and lined pipe was backfilled with lake-shore sand.

Installing Dresser-Coupled steel pipe for the first time in sewer work, and leaving construction of lateral lines to building developers, the New Orleans Sewerage and Water Board saved 25% on this force main project.

The lighter weight steel pipe was hauled to the job by a lumberyard-type "Hyster" truck. Longer pipe lengths required less handling, fewer joints per mile

Despite the fact that this line was laid in soft trench, through peat bogs, clay and quicksand, the contractor was especially pleased at the ease and speed with which the steel pipe was joined with Dresser Couplings.

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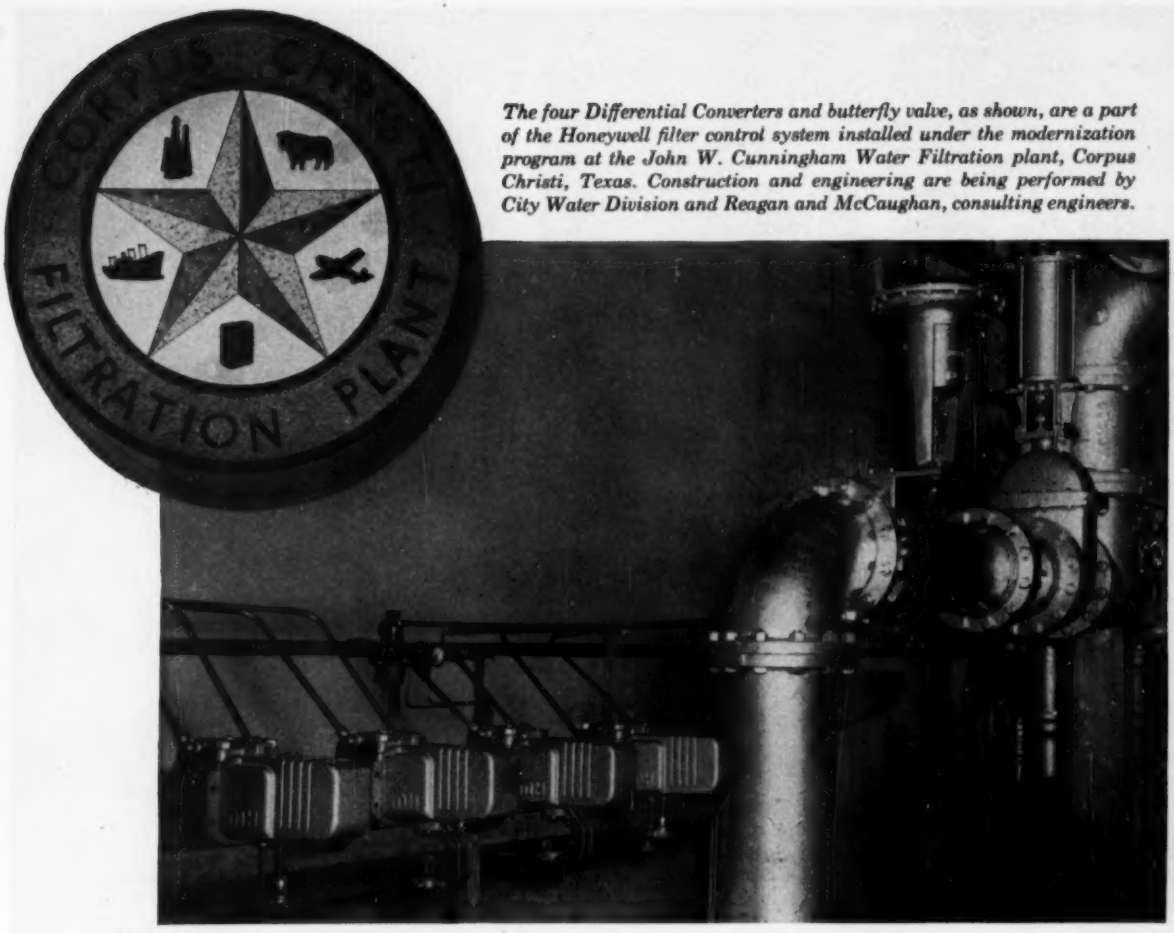

The four Differential Converters and butterfly valve, as shown, are a part of the Honeywell filter control system installed under the modernization program at the John W. Cunningham Water Filtration plant, Corpus Christi, Texas. Construction and engineering are being performed by City Water Division and Reagan and McCaughan, consulting engineers.

Engineered instrumentation simplifies operation of sand filters

How will you have your sand filter control . . . manual, semi-automatic or full automatic? With the integrated Honeywell control system, filter operators can choose at will the exact kind of control they need at any instant . . . without leaving the control room or filter operating floor.

This modern method of regulating sand filters utilizes Honeywell instrumentation that has been service-proved not only in water and sewage applications, but in thousands of critical industrial processes. This team of instruments combines flexibility, simple construction, easy operation and low cost.

Honeywell Differential Converters are the remote measuring elements which transmit data on flow rate and liquid head to miniature *Tel-O-Set* indicators and controllers on the central panel. Built-in switches let the operator designate how flow is to be controlled . . . automatically in accordance with clear well level, reservoir level or manual setting . . . or manually by means of settings at local or remote control stations. In addition, automatic recording instruments chart a precise, continuous history of each critical variable.

Your local Honeywell sales engineer will be glad to discuss your own applications for this system with you and your consulting engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Bulletin 2290, "Differential Converter Transmitters."**

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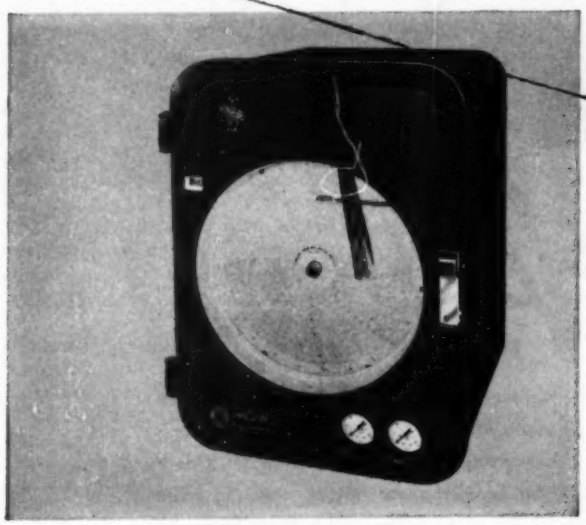

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Using a Low Cost Primary Element . . . 50% of 6″ full scale differential is *only 3″ PPL*

The Hagan Ring Balance Meter is particularly adapted for accurate operation at full scale differentials as low as 1″ WC, with *any* type of primary element. In many applications, by choosing a low cost, low differential element, with a PPL of 50% or more, and measuring the flow with a Ring Balance Meter, the actual permanent pressure loss is low. In the example shown above, *it is only a third of the actual PPL* sustained with a high cost, high differential primary element. Here is positive, long range economy . . . lower pumping costs result from reduced horsepower requirement.

This is an example of how Hagan experience and engineering skill can reduce costs. Hagan engineers will be glad to recommend the most economical solution to your metering problem.

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The Neptune Meter Company has adhered to this principle for over 50 years. During that time many improvements have been made to Trident meters. Yet none of these has affected the basic design of the meters. The oldest Trident can be modernized with new, improved Trident parts. Rebuilt or brand-new, Trident is still the finest meter you can buy. Ask your neighbor . . . or ask the Neptune representative next time he calls.

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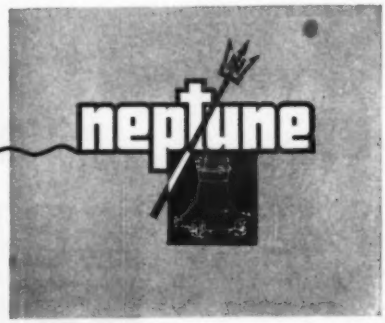

260

Improved Water Filtrability Test

Laboratory apparatus employs a "microscreen" to measure filtrability index and an automatic unit provides a continuous record

by D. H. MATHESON

Mr. Matheson is Superintendent, Water Filtration Plant, Hamilton, Ontario, Canada. He here reports on a two-year study of water filtrability as correlated with plankton content, actual filter runs, and other variables. His laboratory determinations have been supplemented by the use of a plant-scale recording meter.

ONE serious deficiency in the laboratory control of water purification processes is the lack of a suitable method of measuring the varying resistance of water to filtration. Many years ago, Sir Alexander Houston devised a method to obtain semi-quantitative values for the resistance to filtration of waters having a varying algal content. His method suffered because of the lack of reproducibility of results, due to the cloth filter medium which he employed. It was not until 1946 that Boucher[1] placed the determination of filtrability on a sound basis, both mathematically and experimentally, and so provided an additional valuable aid in filtration plant operation.

This article deals with the results of a two-year study of the filtrability of raw and treated water at the Hamilton Filtration Plant treating water from Lake Ontario. Laboratory determinations of the filtrability of individual samples have been correlated with the plankton content, the actual filter runs, and certain other variables, and have been applied to the laboratory evaluation of plankton-removal treatments. The laboratory determinations have been supplemented by the use of a recording filtrability meter, and together they have yielded valuable operational information not otherwise available.

Filtrability Index Apparatus

The laboratory determination of the filtrability index uses an apparatus of the type devised by Boucher, as shown schematically in Fig. 1. A stream of filtered water, *A*, passes through a constant head device, *B*, and through a stopcock, *C*, to a cotton plug filter, *D*. At the top of the tube containing this filter is a trap to remove entrained air bubbles which are vented as required through the cock *E*. The stream of water then flows downward through the filter membrane, *F*, clamped between two separable brass adapters, *G*, and thence through a flow-regulating needle valve, *I*, to a flowmeter, *J*. A differential manometer, *M*, connected to the adapters above and below the filter membrane, indicates directly the loss of head across the filter occasioned by the flow rate indicated by *J*. Provision for introducing the measured volume of sample is made by the funnel and cock, *S*.

The unique feature of this apparatus is the filter membrane, a one-half inch disc of "microscreen" mounted in a brass holder, and supplied through the courtesy of Dr. Boucher. The microscreen is a remarkable fabric woven of stainless steel wires, which presents apertures of a maximum diameter of 35 microns. It is structurally strong, identical when one disc is compared with another, very stable in its filtering properties as used in this apparatus, and readily and quickly cleaned after use. The fabric is produced on a commercial scale for use in apparatus designed for plankton removal in water treatment[2].

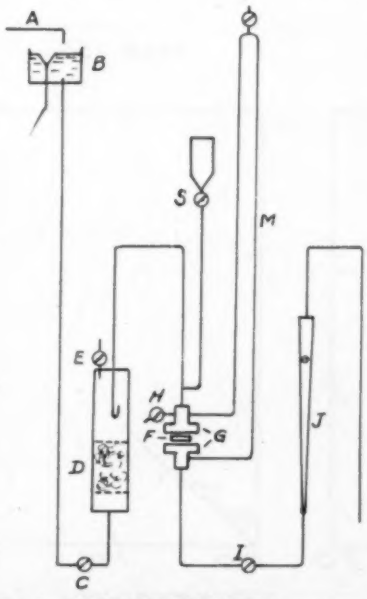

Fig. 1—FILTRABILITY INDEX apparatus, the laboratory setup.

Operation of the Apparatus

The filtrability determination is made by establishing a constant flow of water through the apparatus, as indicated by *J*. The loss of head occasioned by this flow through the clean filter is recorded as H_0, and amounts to 8-10 cm at a flow rate of 200 ml per minute. The sample is then introduced by operating cock *S* and cock *C* simultaneously. When this is completed, the flow of clean water is re-established by reversing the two cocks at the same time. The flow is then readjusted to the original value by means of *I*; and the loss of head, H_1, through the filter and the deposited mat of particles from the sample, is read from the manometer. The disc is then removed and cleaned. By using a forceful jet of water, no difficulty is experienced in restoring the disc to its original resist-

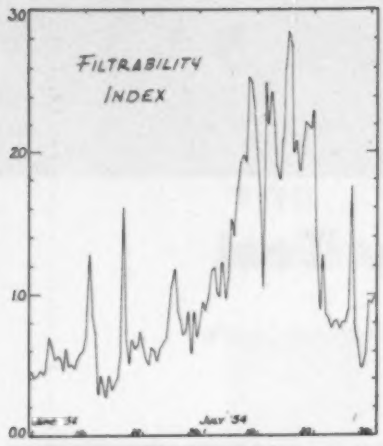

Fig. 2—FILTRABILITY index plot
Raw water, Hamilton, Ont., plant
(Index parallels plankton counts)

ance. The whole determination can be performed in a very few minutes and is highly reproducible.

The filtrability index, I, is defined by Boucher as follows:

$$I = 0.385/V \times ln\ H_1/H_0$$

where I is the filtrability index,
V is the volume of sample in units of 100 ml.,
0.385 is a constant applicable to the microscreen filter, and
H_0 and H_1 are the initial and final loss of head values in any consistent units.

The filtrability index determined in this way is independent of the viscosity of water if the clean water flow is at a constant temperature. Within certain limits the index is also independent of the volume of sample filtered. The volume, however, should be chosen so that the ratio H_1/H_0 is at least 2.0 (in order to obtain accurate manometer readings), and less than 4.0 (to avoid forcing part of the filter mat through the screen by excessive pressure).

It is convenient for rapid work to prepare a table showing, for a unit volume of 100 ml, the values of I corresponding to the ratio H_1/H_0 within this range. For samples of other size the value of I is readily obtained from the table by multiplying by the appropriate factor. The filtrability index of perfectly clean water is 0.0, and increases as the amount of particulate matter increases.

Seasonal Variations

Since the filtrability index is a measurement of the total amount of particulate matter in water, it may be expected to vary seasonally as the plankton content varies. Fig. 2 shows a plot of the index of the Hamilton Filtration Plant raw water for June and July, 1954, during which period the turbidity remained within the narrow range of 2-5 ppm. The summer increase in the index, from 0.2 to 0.4 in the winter, did not appear in this year until the beginning of June, and reached a maximum value of 2.8 during the middle of July. This highly significant increase in resistance of the water to filtration closely paralleled the plankton counts made on the same samples used for the index determination.

The rapid fluctuations in the index are accounted for by the oscillations of a well-defined thermocline which is frequently established in the lake at a depth approximating that of the intake mouth. Caused by variable winds, these oscillations result in the intake receiving at different times water from above, at, or below the thermocline. Since the plankton concentration is greatest just above the thermocline, rapid changes in plankton counts and in filtrability index are exhibited, and are associated with corresponding changes in water temperature.

Index Correlation

An exact correlation between the plankton count and the filtrability index would be highly desirable, but on consideration of the nature of the variables involved, it is scarcely to be expected.

Fig. 3 shows three sets of data obtained at different times when careful plankton counts and filtrability index determinations were made on the same samples. The difference in the slope of the trend lines indicates that factors other than the areal standard units of plankton affect the index. These factors could be determined by a difference in the plankton species involved; by general growth characteristics such as the length of filaments and the existence of a gelatinous coating; and by the presence of amorphous particulate matter not normally included in plankton counts, occurring in quantities too low to cause appreciable turbidity.

A very fair correlation is obtained when the filtrability index is plotted against the length of run of the plant

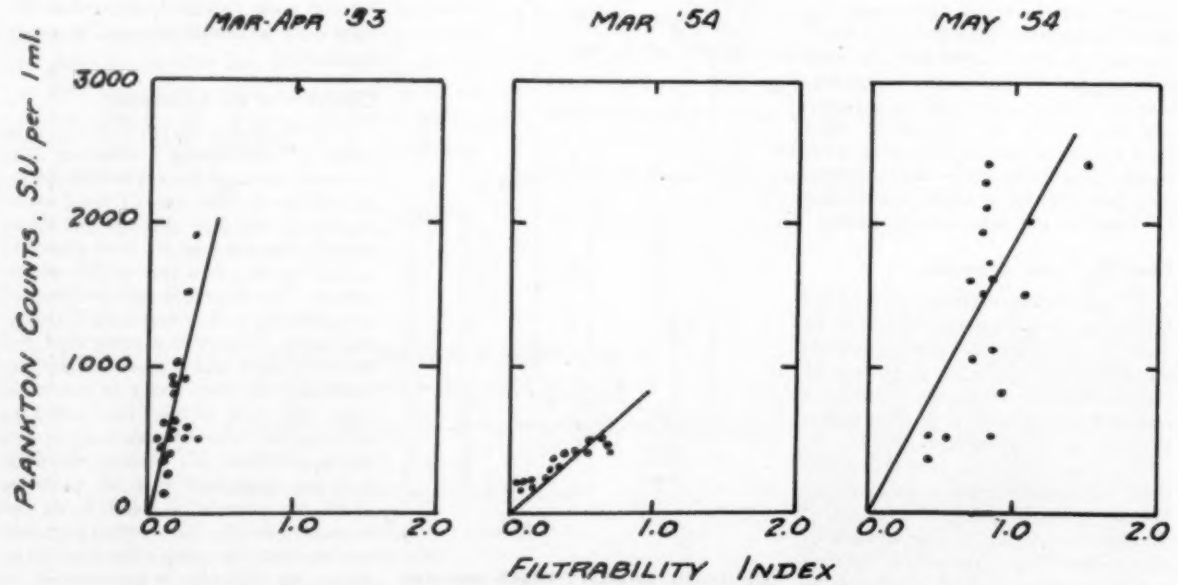

Fig. 3—FILTRABILITY index compared with plankton counts made on the same samples

filters, as shown in Fig. 4 where data of July 1954 are plotted. The curve is calculated on the assumption that the runs of plant filters vary in length as the reciprocal of the index. The scatter observed here is attributable not only to the above variables but also to the effect of varying temperature on the runs of plant filters. We must recognize the fact that the index is based on individual spot samples collected from a variable raw water, while the filter run figures represent an average of the raw water variations over a period of hours.

Automatic Metering

Since the determination of the filtrability index is of definite value in the operation of a filtration plant, it appeared advantageous to have an instrument capable of performing the determination automatically at frequent intervals, and of recording the results. Boucher patented such an instrument in 1951[3]. A somewhat similar device embodying an available electric meter was constructed at Hamilton in 1952, and has been operated almost continuously since then. The record from this instrument provides a much more detailed record of the raw water variability than can be realized from taking a few spot samples each day. A sample of the data plotted from meter records is shown in Fig. 5. The meter record is slightly affected by changes in water temperature, but by far the greater part of the variation shown actually is due to the changing filtrability of the water.

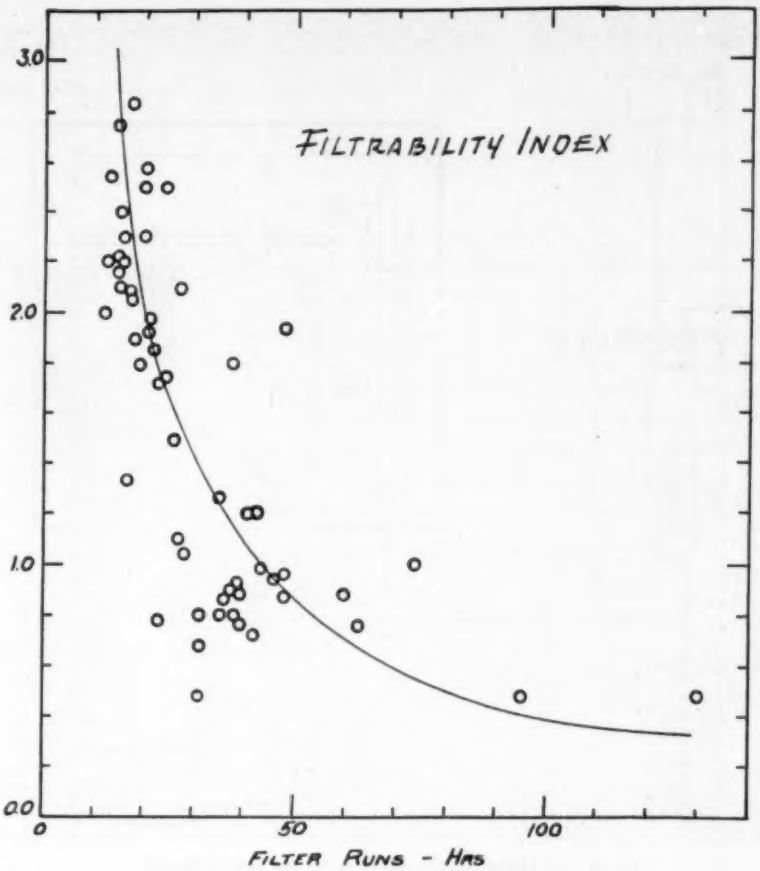

Fig. 4—CORRELATION curve of filtrability and filter runs

Meter Operation

A schematic diagram of the recording meter is shown in Fig. 6. We used an old-style G.E. recording watt-hour meter, incorporating a kelvin balance. The mechanical portion of the balance, *A*, with the coils removed, was converted to a recording manometer by utilizing the changing weight of a plastic rod, *B*, suspended from one end of the balance arm and partially immersed in water in the manometer, *C*.

In this unit, it was necessary to use as the filter medium a shallow bed of very fine sand in place of the microscreen disc. The sand was used since it would be difficult to wash the microdisc adequately without the use of a jet of water.

Meter Calibration

The four valves *E*, *F*, *G* and *H* are operated by a solenoid and function in pairs, as in normal filter operation. The filter effluent passes through valve *H* and to an orifice, *I*, which serves to maintain a substantially constant flow since the maximum loss of head (amounting to about 10 cm) is small compared with the total head applied to the orifice.

At the start of a run the recorder pen leaves the left-hand side of the

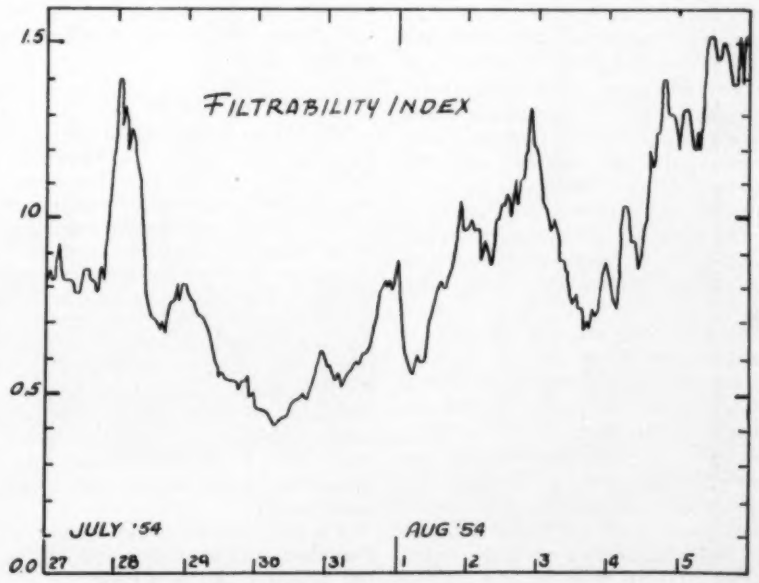

Fig. 5—FILTRABILITY index determined by automatic recorder

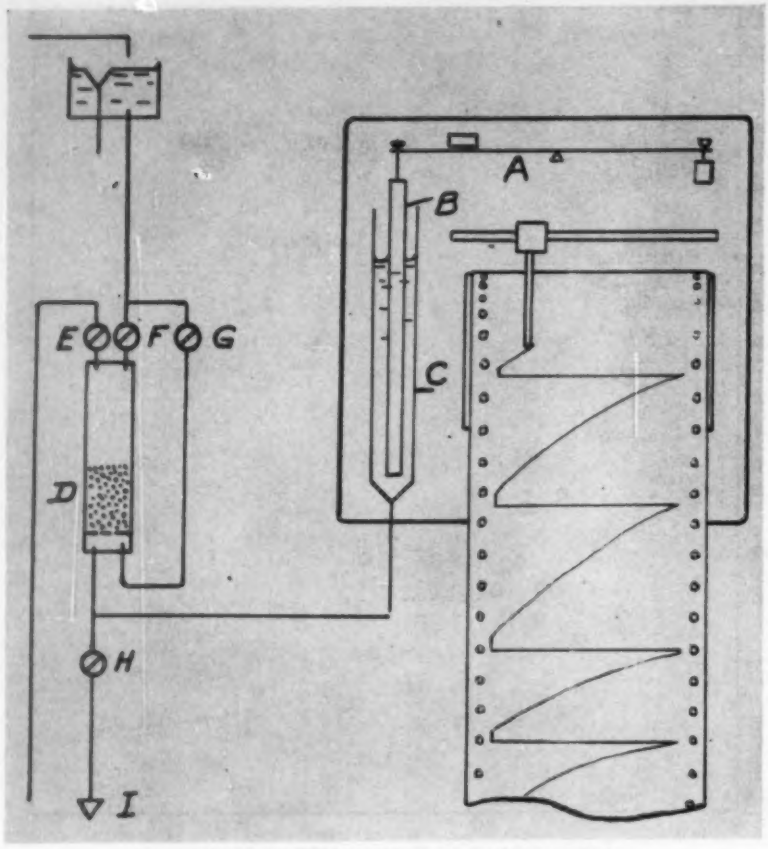

Fig. 6—AUTOMATIC filtrability meter and control device

chart and draws a curved line, plotting the loss of head of the filter against time and therefore against volume filtered. When the pen reaches the right-hand side of the chart it starts a cycling device, which washes the filter by actuating the solenoid controlling the four valves, and places the filter back in operation again. Immediately thereafter, the solenoid energizes a heavy buzzer clamped to the filter tube; the buzzer vibration, together with the downward flow of water, compacts the sand bed to a reproducible density.

The meter is calibrated by determining the loss of head corresponding to each of two graduations at either edge of the chart. From these values, H_1/H_0 is obtained. The number of minutes required by the pen to travel between these two lines is proportional to the volume of water filtered. If, then, I is determined in the laboratory on the water sample delivered to the meter, a value can be calculated for the constant in the filtrability equation. Since H_1/H_0 remains constant, I_m, the index measured by the meter, varies inversely with the time interval indicated by the chart.

The instrument is operated as a secondary device only, being kept in constant calibration by frequent checks with the laboratory determination. The instrument readings therefore serve to complete the record provided by the spot samples determined by the manual method.

Additional Applications

In addition to its value in interpreting plant performance, the filtrability index is an attractive means for studying on a laboratory scale the effects of specific water treatments, especially those designed for plankton removal.

Storage of water in the laboratory results in a reduction in I amounting to as much as 33 per cent in one week, presumably caused by the disintegration of organisms which have died under prevailing unfavorable conditions. The effect of sedimentation is readily demonstrated, but it has been noted that settling in laboratory vessels takes place much more rapidly than in the plant basins.

The effectiveness of varied doses of coagulants in coagulating and settling our plankton can be assessed by this procedure, but cannot be done readily by other techniques. The initial I increases due to the formation of floc, and then decreases significantly as the plankton organisms are entrained and removed by sedimentation.

The effect of increasing doses of chlorine on algae can be followed by employing gentle mechanical stirring to prevent sedimentation. Boucher indicated that I increases with increasing chlorine doses up to the break-point and then decreases, apparently due to the coagulation of colloidal matter and to its subsequent destruction by the free chlorine. With a predominantly diatomaceous plankton, however, there appears to be only a slow continuous reduction in I with increasing chlorine doses. The chlorine-treated organisms settle more rapidly than do those in the untreated control samples. Treatment of similarly stirred samples with increasing doses of copper resulted in a definite and permanent increase in I, presumably due to the coagulation of organic matter. Subsequent settling is not appreciably better than in the control samples.

Conclusion

Continuous yearly records have been obtained, by manual and automatic means, of the filtrability index of raw and applied water. These records provide valuable information in assigning causes for variations observed in the performance of plant filters.

The filtrability index determination is made by the laboratory method more quickly than plankton counting; it appears to correlate better with plant performance, and it is applicable to the laboratory evaluation of treatments for plankton removal.

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2. Boucher, P. L. "Microstaining." *J. Inst. Water Eng.*, 5:561-95 (1951). Hazen, R. "Application of Microstaining to Water Treatment in Great Britain." *J. A. W. W. A.*, 45:723-37 (1953).
3. Boucher, P. L., and Rowntree, N. A. F. "Means for Measuring and Recording the Filtrability of Fluids." U. S. Patent 2,572,436.

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It's a fact money cannot buy happiness, but it places the possessor in an excellent bargaining position.

Machines are able to do everything today except make a dollar go as far as it used to.

Meter Maintenance to Increase Revenue

Cortland, N. Y., initiated a meter testing and repair program which reduces water waste and power costs

by DANIEL J. HOULIHAN

Mr. Houlihan, Superintendant of the Cortland, N. Y. Water Board, describes a profitable meter maintenance program which, over a three-year period, has reduced water pumpage over 165 mg per year, and has increased revenue from water sales more than $9 thousand per year.

CORTLAND initiated a modern meter testing and repairing program in 1950. It can now be reported that, as a result, revenue has gone steadily up while water pumped and power costs to operate the pumps has steadily decreased.

We feel the program has been working to our advantage very well. Of the 4322 meters in the Cortland water system, 2250 have been tested in the first four years of the new program. This figure includes 250 new meters installed in new homes. Of the number tested 1540 (almost 20%) were found in a condition to require rebuilding or replacement.

The figures for revenue derived from water sales receipts tell the story most effectively:

1950 Receipts	$68,957.00
1951 Receipts	$72,622.07
1952 Receipts	$74,843.35
1953 Receipts	$78,071.21

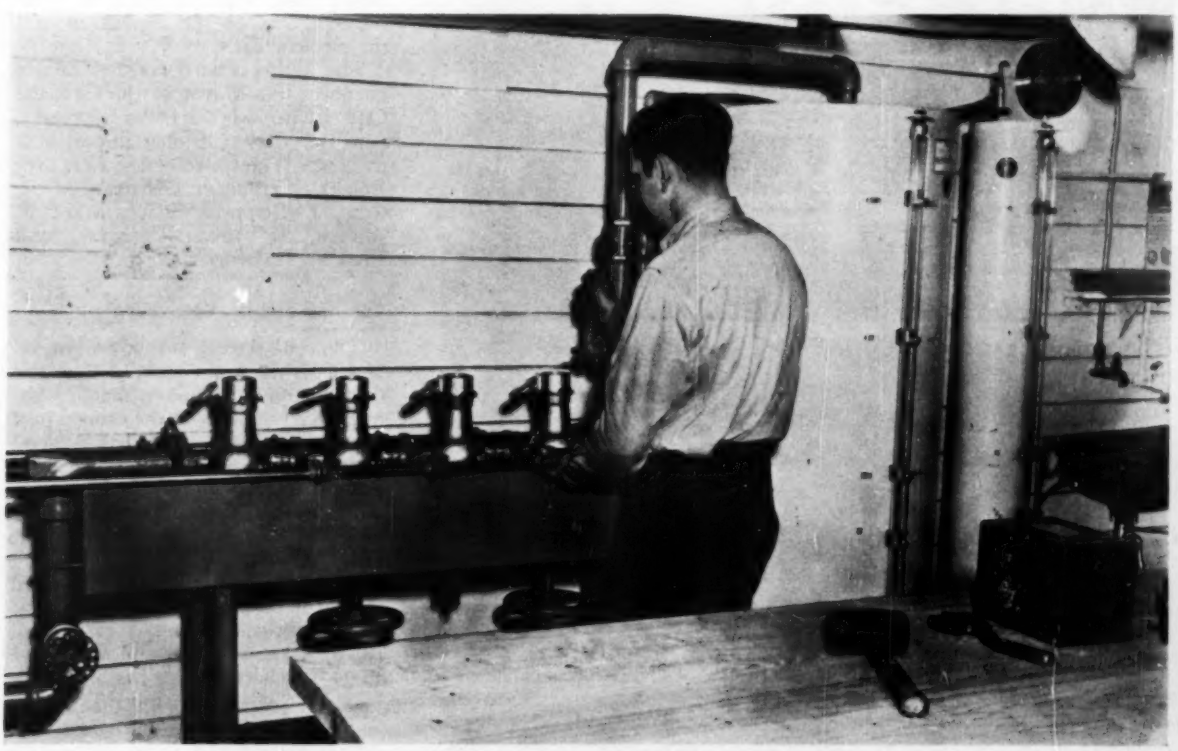
This increase of $9,114.21 in revenue for 1953 over 1950 has helped to meet the higher cost of operation, including increasing cost of equipment and materials over the past few years.

At the same time, the meter testing program, despite the slight increase in number of customers, has resulted in a definite reduction in water pumped. The only explanation is that a reduction in water waste and customer carelessness accounts for the lower pumpage.

The gradual drop in water pumped since the meter program was started can be seen in the following:

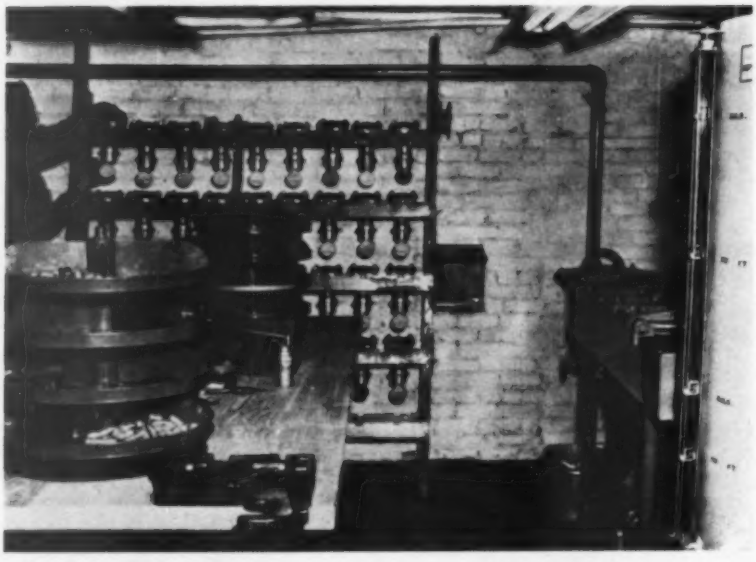
1950	972,664,000 gallons
1951	954,497,000 gallons
1952	846,163,000 gallons
1953	807,422,000 gallons

The decrease in total amount of water pumped naturally is reflected in the annual expenditure for power to run the pumps:



A FOUR-UNIT TEST BENCH is the key to Cortland's meter maintenance program

COMPACT ARRANGEMENT is a feature of the meter maintenance shop



METER STORAGE RACK stores renovated meters in upside-down position

1950	$9,018.00 for power
1951	$8,731.92 for power
1952	$7,638.00 for power
1953	$6,505.20 for power

From these figures it can be seen that water pumped has been decreased by 165,242,000 gallons during 1953, as compared with 1950; and, the power bill for 1953 was $2,512.80 less than in 1950. At the same time the Water Board is getting paid for a higher per cent of water pumped than in the past.

Meter Test Program on 10-Year Basis

Our meter test program is set up on a 10-year basis, with the aim of testing 500 meters a year, so that by the end of the 10-year period we will have all meters tested and brought up to efficient operation in line with A.W.W.A. standards.

One man is assigned full time to this meter program, and except for emergencies when he is called to join other crews, he devotes most of his time to testing and repairing those meters which do not meet the requirements.

Before taking on this assignment, the meter man was given a special testing and repair training course at the factory of Neptune Meter Co., which manufactures the meters upon which the Water Board has standardized.

While the increase in revenue can be credited directly to the fact that there is a higher percentage of meters accurately recording water delivered to users, the decrease in water pumped is ascribed partly to metering but also to the water waste survey conducted by the Water Board.

Water Waste Survey Pays Off

For the past three years concentrated effort has been directed toward our water waste survey as an essential part of our program of water conservation through maintenance of a good tight water system. We have found that the job of locating and repairing leaks is well worth the effort and cost for these reasons:

1. A decrease in the amount pumped saves water, which is especially important in summer;
2. It saves on the power bills;
3. It saves on costs of chemicals needed for treating water and saves wear on equipment.

These programs have been developed over the years, since the Water Board first was formed in 1907 through acts of the legislature and the city council.

The Water Board consists of six members, the Mayor of the City, the City Clerk, who acts as secretary, and the City Chamberlain who is treasurer. The six commissioners are: Robert E. Hollister, chairman, M. A. Case, J. Dempster Place, Mark E. Maxon, H. Justin Corcoran, and Fred F. Titchener.

Cortland and Its Water Supply

The city, with a population of 18,000, is the county seat of Cortland County and is located in the Tioughnioga River Valley in the central part of New York State. Served by good highways and important branches of railroads, it is the shipping center for an extensive farming and dairying area and a trading center for about 55,000 people.

Among Cortland's 40 diversified industries are the manufacture of motor trucks, forgings, corsets, wall paper, fish lines, wire and nails. The State Teachers College has an enrollment of about 1,000 students.

The municipally-owned water system is supplied by three wells—two shallow and one deep. One shallow

well is 15′ deep and 20′ in diameter and has supplied the city with water for over 30 years. The other shallow well is about 18′ deep, and 56′ in diameter and is used as a standby only.

The deep well is 26′ in diameter and 72′ deep. It has a yield of about 9,000,000 gallons per day. The pump and the 200 hp motor are of the submersible type, with the motor located in the bottom of the well and having some 68 feet of water over and around it.

In the Cortland water system there are 46 miles of water mains varying in size from 4″ to 18″. On some streets in the business district we have the dual main system, with one water main on each side of the street to give better fire protection and service. There are 403 hydrants owned by the water utility and 28 hydrants owned by different factories. The latter are generally located on sprinkler system supply lines. The average pressure in the city is about 70 pounds. Average daily consumption including residential and industrial is about 2,600,000 gallons or approximately 120 gallons per capita.

There are 502 control valves in the system placed at street intersections for the purpose of shutting off water in case of broken main or broken hydrants. Valves are very important to a good system and shorten the area that will have to be shut off in case of trouble.

Along with mains, hydrants, and valves, meters are amongst the items of equipment most essential to a water system. In Cortland, meters are located on all church property, schools, hospitals, YMCA, YWCA and library, Salvation Army and other charitable organizations. While these institutions pay a maximum annual rate of $5, the meter record makes possible the accounting of water pumped and delivered.

The 4,350 meters in the system are read four times a year and the property owner is billed quarterly. The minimum amount charged for water is $5 per year per meter. In Cortland the largest amount of money earned comes from the domestic customers.

Handling Leakages

Leaks in a water system are costly to the utility, whereas leaks inside the building are particularly so for the customer. Whenever the reading of a meter shows a sudden increase the property owner is notified by postcard, telling him there is an increase in his water bill and asking him to check for leaks and have any leaky faucets or toilets repaired. The customer is also notified as to the amount of money his bill has increased. This procedure saves a number of complaints resulting from high bills, because we tell them first and bill later.

Leaks in water mains and underground pipes are something that nobody gets any pay for but which at the same time cause much damage. Water main leaks if not repaired promptly may cause the street to settle.

Leaks are something you have to work on all the time. The most common causes of leaks are split pipes, broken water mains, blown joints, cracked valves, frozen water pipes, ground vibrations and heavy traffic. Many of the leaks never show on the surface. These have to be located with special equipment such as geophones, acquaphones, electric leak locators that detect ground vibration caused by high velocity leaks.

Water-Shed Management and Public Relations

An important part of the Cortland water system is the water-shed, consisting of some 240 acres planted in pine, spruce and cedar. Trees are planted 1,200 to the acre and later thinned out and pruned. It is estimated that some 275,000 trees have been planted on the property, but 60,000 or 70,000 have been cut down for Christmas trees and thinning and pruning projects.

Sale of timber from the watershed over the years has contributed to the Water Board's revenue. Last year $750 came from this source.

At the edge of the forest, adjacent to the water works, plant members of the water board crews have built up a small zoo that is appreciated by the young folk (and old, too) of the city. Present population includes seven deer, six peacocks, a canary, two racoons, golden pheasants, swans, ducks and chickens.

Another important phase of the Board's public relations program is that of maintaining the grounds around the water plant in attractive condition. An effort is made to keep lawns and shrubs in proper condition at all times. Cortland citizens visit the works frequently to see the "zoo," the fish in the lake and the flower beds on the property.

But it is at Christmas time that hundreds of cars come not only from Cortland, but from surrounding communities to enjoy the lighted decorations on the lawns and on the main water works building.

W&SW

Christmas Comes to the Cortland Water Plant

Our cover photograph is one of two pictures supplied by Supt. Houlihan to illustrate the attractive Christmas decorations at his plant. A second photograph, below, shows a later development in display.

BEFORE—Wood filters being replaced by steel. One of the 53-year old units is shown.

How We Remodeled

How Waynesburg, Pa. replaced 53-year old wood filters with a modern installation of steel units

THE Waynesburg Water Company was founded in 1879 and located its first pumping station along Ten Mile Creek in Greene County, West Waynesburg, Pa., from which stream the water supply was obtained. The Company serves the Borough of Waynesburg, East Waynesburg, and Franklin Township, which together have a total population of approximately 8,000.

As there were no laws in early years to control stream pollution, it became necessary to change the location of the pumping plant due to the wastes discharged by a tin mill directly west of the plant. The new site is farther west along Ten Mile Creek, at the confluence of Ten Mile Creek and Browns' Run. This action was taken in the year 1900, at which time two wood filters were installed for treatment of the creek water.

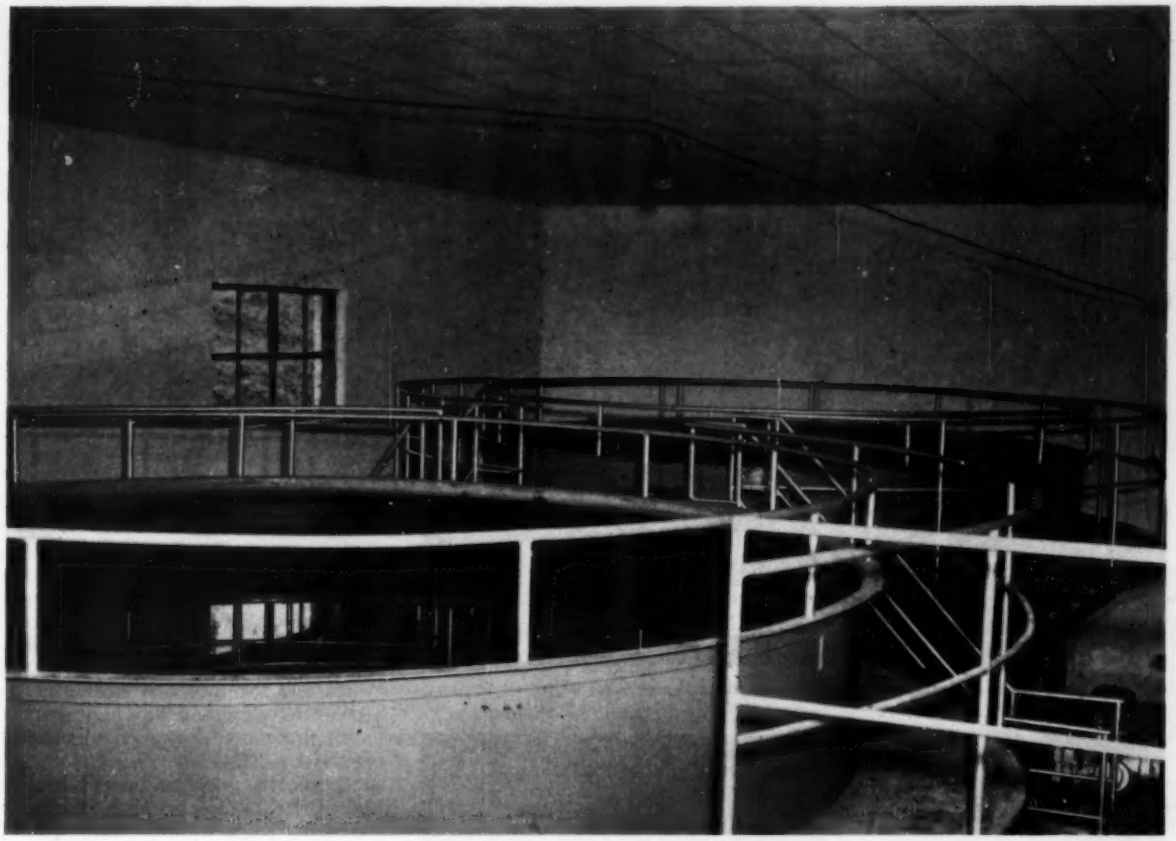
Replacing Old Wood Filters

This paper relates mainly to the problem of replacing the wood filters, which had been in service 53 years and had become non-serviceable. We decided to adapt modern steel filters to the piping in existence so as to keep costs to a minimum. At first thought this may seem like a small problem, but not one man in our four-man crew had any prior experience in this type of work. Before the start of our remodeling program the distribution system crew was used mainly for the maintenance of existing facilities and to install service lines. New construction was ably carried out by a crew from the Citizens Water Company of Washington, Pa., an associated company.

When it was decided to replace the wood filters, work orders, requisitions and purchase orders were processed by the offices concerned. The steel filter units were shipped to us by the Alexandria Water Company of Alexandria, Va. These filters had previously been in service at Alexandria. They were shipped by truck and were easily handled on two flat-bed trailers, with one complete filter unit on each trailer. Each of the filters was cut in four sections before shipping—thus making it easy to unload and store the units until we were ready to begin the installation.

Used Steel Filters Purchased

Upon the receipt of the material we checked every item to determine its serviceability, and to learn just what would be required to place everything in first class condition. The filters were found to be slightly pitted and very rusty. The corrosion which had built up in the fittings proved to be of minor nature and easily removed. The valves were in a poor state of repair,



AFTER—Steel filters and improvements to the building modernize the treatment plant.

an Old Filter Plant

by G. E. MARTIN

Mr. Martin is Manager, The Waynesburg Water Co., Waynesburg, Pa. He describes how a local four-man crew dismantled wooden units and rebuilt circular steel filters. His paper was presented at the 27th annual conference of the Pennsylvania Water Works Association.

as the gates were badly worn and the stems were bent. These conditions were corrected immediately.

We made a particular effort to determine just what fittings would be needed in addition to those received with the filters. It was at this time we learned of an abandoned filter plant located at McDonald, Pa., which had been operated by the West Penn Water Company. This proved to be a "gold mine" as a source of the needed fittings.

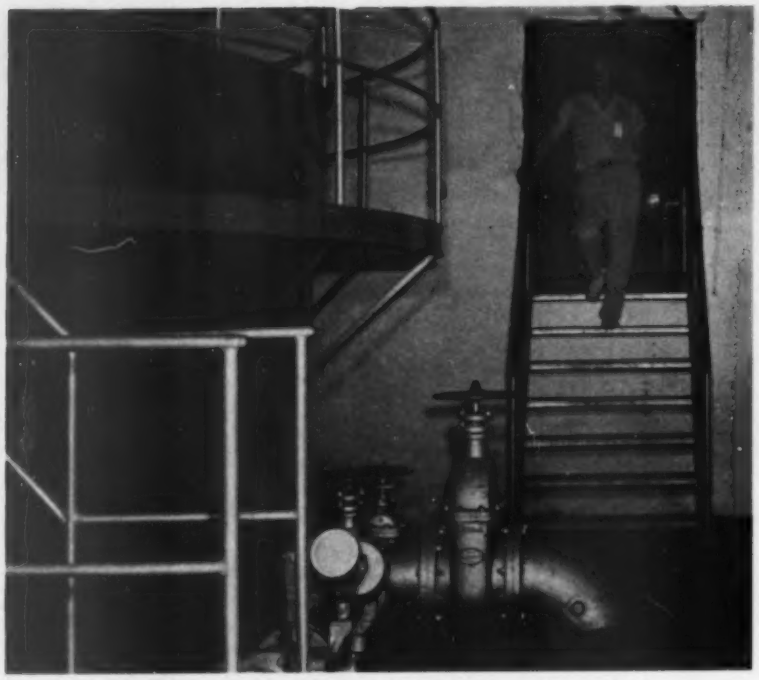
We were then ready to prepare all material for installation. The rust was removed from the steel filter shells down to bare metal. For this work we used a 6-in. rotary wire brush attachment on a ½-in. electric drill. We then coated the filters, first with red lead and then with metal paint known as P-5 which had been recommended to us by a local paint supplier. Upon completion of this work, the filter shells were ready for installation. We followed much the same cleaning and painting procedure on all the fittings.

At this point we started to dismantle wood filter number one. We first disconnected all piping attached to the filter, and then used a cutting torch to remove the steel bands which held the filter staves together. This permitted all the boards which formed the sides of the filter to spring outward with the exception of the four holding the wash trough in position. After removing all the planks which had sprung outward we then cut the bolts holding the wash trough.

We were now ready to remove and discard the sand and gravel. To perform this operation we used a Cletrak which was small enough to maneuver in the limited space formerly taken up by the first filter.

Filter Foundation Required

Upon completing the removal of sand and gravel, we prepared the form for the base of the new filter. To do this we first drove 2-in. pipe into the ground a distance of ten to fifteen feet



OPERATING FLOOR of the plant, showing connections to new filter units.

WELDING of filter shells and new piping make a modern installation.

until we hit rock, and then filled the pipe with concrete. This support was necessary as the ground formation underneath the filter room is much like quicksand. It is best described as a blue mucky substance which will hold no weight; in fact, when working in this soil we find that when one shovelfull is removed, three slide in! We also used ¾-in. reinforcing rods to further strengthen the base for the new filter unit.

After pouring the concrete for the base and allowing it to set for 72 hours, we then moved the bottom sections of the steel filter into position. This was accomplished through the use of planking, rollers, and block and tackle. Note that we used little power-operated mechanical equipment throughout this entire installation.

After lining-up the bottom sections of the filter shell with the existing piping we had the welder go to work. We found it impractical to weld the piping directly to the old cut. Instead we used 2 x ⅜" strap iron throughout the entire installation where piecing together was required. This practice speeded assembly work and decreased the amount of welding.

We also found it necessary to weld two beads on the filter shell, as one would not properly hold the sections together nor make them water tight. Two beads gave us a stronger union of the pieces; and where the parts had been sprung during shipment, they could thus be pulled into place and held with the extra bead. After the filler bottom was in pl we next installed the three-piece anifold pipe and the 60 laterals. This was easily done as it required only nut-and-bolt assembly and lead joints.

The Reassembly Job

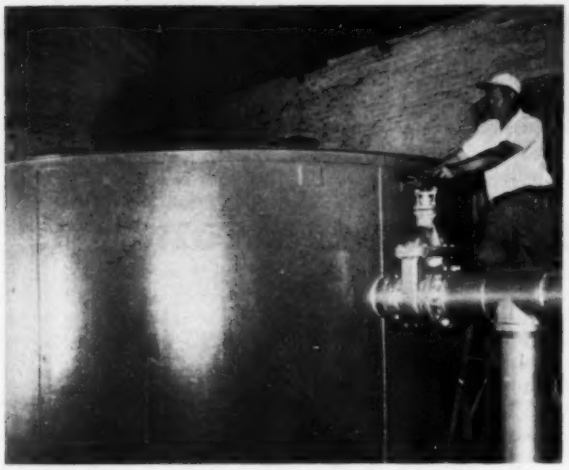
We then spotted 12-in. lengths of strap iron both inside and outside the bottom section. These extended for 6 inches above and below the cut, and were located opposite each other to form a slot so that we could drop the sides in place. Slots were spotted both at the sides and at the center of the bottom section. It was at this point we experienced a little difficulty as the sides of the filter were badly sprung.

Prior to being shipped to us the filters were supposed to have been cut so as to eliminate any warping or springing out of line. We believe that if the shells had been cut into smaller sections, the installation would have been much simpler and easier. As it was, the parts were so badly out of line we were required to spend considerable time reassembling. The additional welding probably would have cost no more than the labor required to line the parts up.

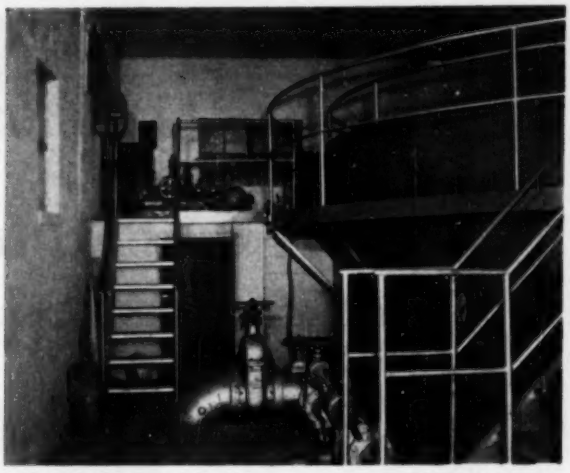
Due to the size of the top sections of the filter we were faced with back-breaking work. It was necessary to raise each section approximately three feet above the floor. This we accomplished with chain blocks rigged to 6-in. x 6-in. wood beams which are part of the framework of the filter room roof. After setting the first top section in place we spotted a few welds around it to hold it in place until it could be joined with the other top section. When both sections were in place we banded them together with strap iron.

The next step was to install the wash trough. This also had been cut in two sections. It was necessary for us to do considerable hammering to get perfect alignment.

Upon the completion of this phase we were ready to begin connecting the filter to existing piping. The only piping change necessary was the installation of a new wash line and replacement of the effluent line. The wash water line on the old filters entered from the rear, and it was necessary to change the location, as the wash water line on the new filters



OPERATING the first steel filter before adding operating floor.



TWO OPERATING LEVELS are shown in the completed Waynesburg plant.

enters the front through a 12-in. x 6-in. x 4-in. flanged cross. The filtered water line of the old filter was of steel and was buried under the floor. Since it showed signs of deterioration, we replaced this line with cast iron cement lined pipe. The location of the drain and influent lines were unchanged. It was necessary to cut holes in the filters to connect these two lines, and this was accomplished with little difficulty.

Placing Sand and Gravel

We then placed new sand and gravel layers in the filter. For both filters we used a total of 46 tons of sand and 28.4 tons of gravel. The filter sand had an effective size of 0.45 to 0.55 mm and a uniformity coefficient not exceeding 1.60. Three sizes of gravel were used, ranging from ¾-in. to ½-in., ½-in. to ¼-in. and ⅛-in. to 10 mesh.

The gravel selected was of hard, durable, rounded particles having high specific gravity, and free from thin flat particles. The gravel was washed and screened free from sand, loam, clay and organic matter. This material was shipped in two open railroad cars, with partitions separating the various sizes of gravel and sand.

This operation completed our number one filter installation. The second filter was installed in much the same manner and, having experience with the first filter as a guide, no particular difficulty was experienced.

To relate all of our experiences during the remodeling program would require great detail. A number of construction details are well illustrated in the photographs accompanying this article. The overall improvements in the once obsolete Waynesburg plant have changed it to an up-to-date and modern treatment plant.

W&SW

Wisely to be ASCE Secretary and Fuhrman to Serve FS&IWA

Ralph E. Fuhrman

W. H. Wisely

Announcement has been made that W. H. Wisely, Executive Secretary-Editor of the Federation of Sewage and Industrial Wastes Assns. has resigned his position to succeed W. M. Carey as Executive Secretary of the American Society of Civil Engineers.

Ralph E. Fuhrman, Deputy Director of Sanitary Engineering, Washington, D. C. is to replace Mr. Wisely in the Federation position. Mr. Fuhrman is to report in Champaign, Ill., on December 1, 1954, and Mr. Wisely is to leave the Federation on December 31st for New York.

Iowa Section AWWA Honors John Pray

During its annual meeting on October 15th, John W. Pray, superintendent of water and sewage works at Fort Dodge, Iowa, was honored by the Iowa Section of AWWA on the exact anniversary of his 51 years of service to the City of Fort Dodge.

Evidence of this took the form of a specially struck bronze tablet on which appears the wording—

Presented to
JOHN W. PRAY
in recognition of his fifty years' service and contributions to the water works industry
by the
IOWA SECTION
of the
American Water Works Association
October 15, 1953

The tablet had been ordered for presentation in 1953 but being delayed in production the ceremony was postponed until the 1954 meeting of the Section. It later developed that Mr. Pray was celebrating his 68th birthday on October 15th, strangely also the birthday of another real American—President Dwight Eisenhower.

On hand for the presentation was Fort Dodge's Mayor Martin B. Vending, who had some complimentary remarks to direct to John Pray and Mrs. Pray.

Adding their congratulations were Dale Maffitt, president; Frank Amsbury, president elect; and Jack Hinman, past-president of AWWA—Maffitt and Hinman, being also members of the Iowa Section.

"Honor to Whom Honor is Due!"

Pumps—Application and Operation

The Seventeenth of a Series

by GEORGE E. SYMONS, Ph. D.
Dr. Symons is Consultant and Technical Editor, Larchmont, N. Y. In this series he discusses *Water Works Practices* in the form of short course lectures. These are designed to assist plant operators, students, and all who wish to review fundamentals in this field.

AS POINTED out previously, pumps are classified by operating principle and by use. This lecture deals with the use or application of pumps, their selection and operation.

A . . . Applications

1. Low Service

a. Pumps used to lift water from a source of supply to a water treatment plant.

b. Generally, low service pumps operate at low discharge heads (pressure) just sufficient to lift the water to the elevation of the treatment plant facilities.

c. Centrifugal pumps (horizontal or vertical) are popular for this service.

2. High Service

a. High service pumps take suction from a clear well (reservoir) and pump the water to the distribution system.

b. The discharge head (pressure) is usually high and should be high enough to provide the desired pressure at all points on the system.

3. Deep Well

a. Because water is often found far below the earth's surface, it is necessary to have pumps which will bring the water to the surface.

b. Deep well pumps are of the plunger, turbine, jet or air-lift types.

(1) In modern plunger pumps, the casing for the check valve and plunger is made of heavy drawn brass tube of very true bore. (Fig. 1)

(2) The casing is placed below the water level in the well and extended up to the pump operating mechanism at the top of the well by tubing.

. . . The tubing is slightly larger than the pump barrel to permit ease of drawing the plunger and valve for repair.

(3) The working parts are a ball valve, plunger and check valves. Dish or other type valves are also used.

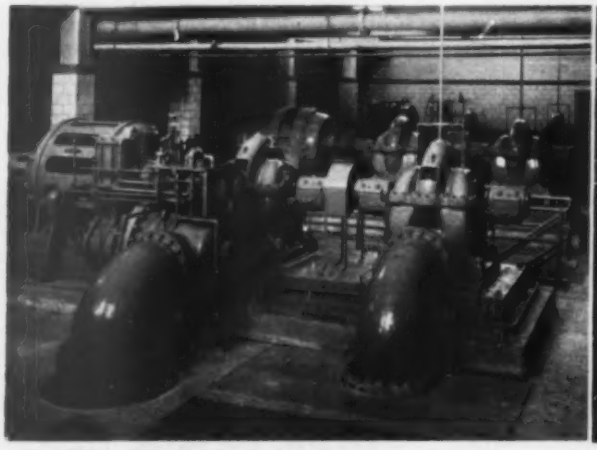
. . . The plunger has four leather packing cups, which can be renewed. Only the plunger moves.

(4) When the plunger is raised, a vacuum is created below it, and water flows through the check valve to fill the void. When the plunger is lowered, the check valve closes, traps the water in the pump, and forces it up through the valve in the plunger; it is then lifted further on the next upward stroke of the plunger.

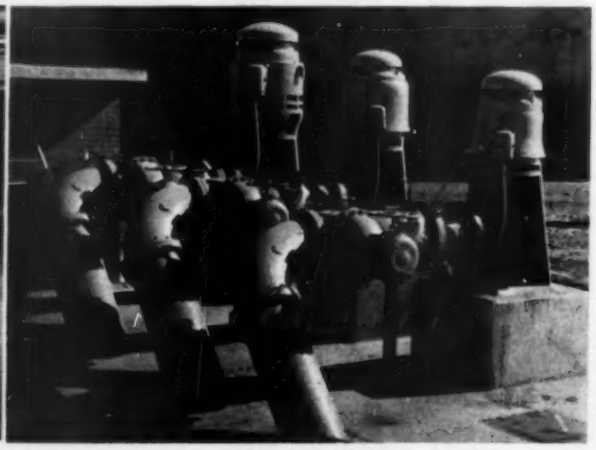
d. Turbine pumps are used for both shallow and deep wells. They are an application of vertical centrifugal pumps to well service.

(1) Capacities run up to 7000 gpm at discharge heads of 1000 ft.; for wells large enough to take a pump 24-in. in diameter.

(2) These pumps consist of two



INDOOR high service pumps—Allentown, Pa.



OUTDOOR high service pumps—Midland, Tex.

parts: The head includes a vertical driving motor, discharge connection and step bearing; the pumping unit is below ground and includes pump column, shafting and pump stages. (Fig. 1)

(3) The number of stages (each consisting of a bowl and impeller) depends on the head to be pumped against.

. . . If the discharge is against a static head above ground, a lift pump in the well lifts the water to ground level and a booster pump immediately below the pump head produces the desired high service discharge head.

(4) Pump parts consist of the pump column (pipe sections 10 ft. long); flanged couplings with bearing retainers anchored in each; shaft (10 ft. sections threaded together with couplings), bearings; bowls; and impellers (semi-open, enclosed, or of special design).

. . . Bearings are usually water lubricated, of non-corrosive metal; in some designs stainless steel sleeves on the shaft run in cutless-rubber bearings. The latter are useful where sand in the water exceeds a desirable minimum.

e. Submersible motor pumps have the motor below the pump bowls with a short shaft; they operate under water at all times. (Fig. 1)

(1) Electrical parts are sealed from the water through a mercury seal where the shaft emerges from the oil-filled motor case. The pump and motor are attached to the bottom of the pump discharge column.

(2) A submarine armored cable and small copper oil line are the only connections to the surface.

(3) Several designs of submersible motor pumps are available; including pumps of many stages for pumping at heads up to 8000 ft.

Cutless-rubber cylinders are also used in the pumping element. The inside surface of the cylinder is formed as a helix with double the number of threads in the rotating part of the pump. As the rotor revolves in the cylinder the water is squeezed upward with a progressive displacement action.

f. Jet pumps, also called ejector-centrifugal pumps, combine a single stage centrifugal pump at the top of the well with an ejector or jet, down in the well. These pumps have been described in Sect. C-4 of the previous lecture.

g. Air lift pumps are popular for deep well pumping. The principles, efficiencies, and methods of operation have been discussed in Sect. C-5 of the previous lecture.

4. Booster and Fire Pumps

a. Auxiliary pumps are located on distribution systems where line pressure cannot be maintained at the desired level by the high service pumps. These are known as booster pumps.

(1) Booster pumps should be electrically operated and automatically controlled, or remotely controlled from a central station.

(2) Control can be based on pressure alone or on a combination of pressure and flow which will supply the desired pressure and the demand on the system.

b. Fire pumps are built to comply with regulations of the National Board of Fire Underwriters.

(1) Fire pumps are motor, steam or gasoline-engine driven.

(2) A single suction is provided to connect with the steamer nozzle of a fire hydrant or to suction lift.

. . . The number of outlets on the discharge manifold depends on the capacity of the pump. Three 2½-in. bronze gate valves are used on a 750 gpm unit; four on 100 gpm; 6 on a 1500 and 2000 gpm pumper.

5. Variable Displacement Pumps

a. Plunger pumps may be designed to vary the discharge. Such pumps are used for high pressures.

(1) Operation is at constant speed but the length of the piston stroke can be varied according to the discharge desired.

(2) Applications in the water works field are rather limited.

b. Proportioning pumps or proportioning feeders are a type of variable displacement pump which is used for chemical feeding in water treatment. They may be of piston or diaphragm type.

(1) Discharge is varied by varying the stroke of the pump.

. . . Discharge is proportioned to some primary flow through control of the speed of operation in direct ratio to the flow to be treated. This control may be effected by several means particularly through the mechanism or system of driving the feeder.

(2) Proportioning feeders may be driven by motor, gasoline-engine, by direct connection to another pump, hydraulic displacement, by the discharge from another pump, by air pressure or by a metering device.

6. Miscellaneous Applications

a. Boiler feed pumps may be either centrifugal or reciprocating of which there are several designs. Their function is to supply water to steam boilers at high pressure.

b. Other applications for pumps in water works practice include:

Air blowers for filter backwash and air operated devices
Ash handling
Cement pumps for construction
Diaphragm pumps for trench dewatering, drainage, dewatering, or sump pumps
Drainage, dewatering, or sump pumps
Sand ejector pumps for filter cleaning
Sludge or slurry pumps for removing sediment from clarifiers or for handling chemical slurries such as lime or activated carbon

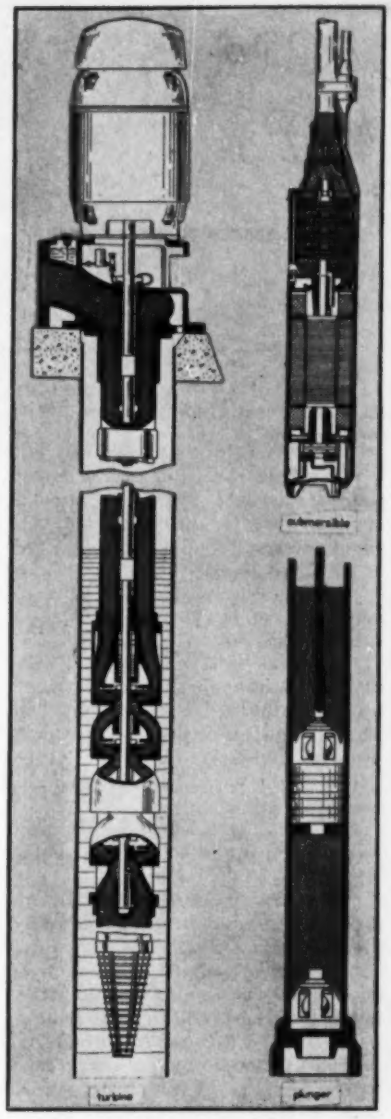


Fig. 1—DEEP WELL pumps

("Report on Water"—POWER, Sept. '52)

B . . . Pumping Terminology

1. Head

a. Measurement.

(1) Heads can be measured in various units; feet of liquid (ft.); pounds per square inch (psi.); inches of mercury (Hg. in.), etc.

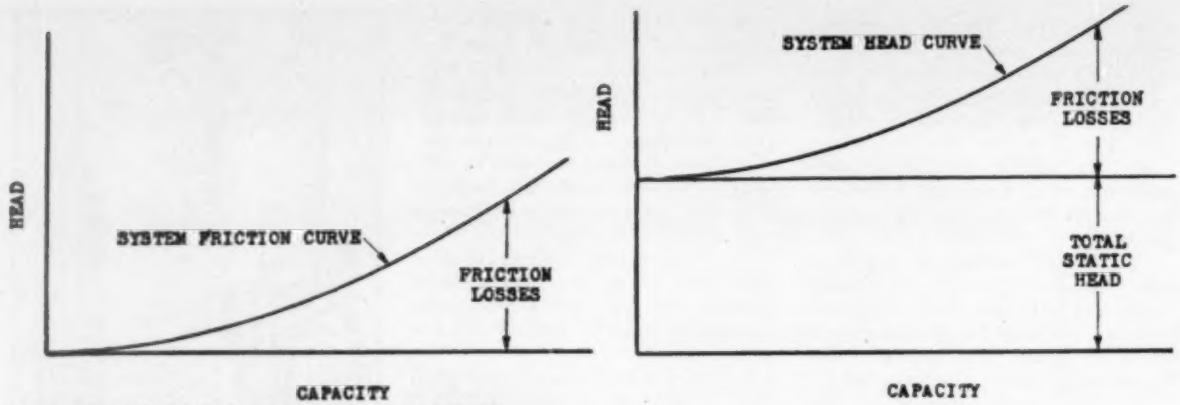


Fig. 2—SYSTEM CURVES—Friction (left); head (right)
by Carter & Karassik

(2) Heads are expressed in either gage or absolute units; the latter is equal to gage pressure plus barometric air pressure (i.e. gage + 14.7 psi at mean sea level).

(3) Multiply psi by 2.308 to convert to ft. of head.

b. Definitions.

(1) Total head of a system: Sum of static head, velocity head, friction head (including entrance and exit losses), and difference in barometric pressure between points.

(2) Static head: Difference in elevation between two points.

(3) Total static head: Difference in elevation between discharge liquid level and suction liquid level.

(4) Static discharge head: Difference in elevation between discharge liquid level and centerline of pump.

(5) Static suction head: Difference in elevation between suction liquid level and centerline of pump.

(6) Net positive suction head: Difference between suction head and vapor pressure of the water; indicated as NPSH.

(7) Friction head: Head necessary to overcome friction losses caused by flow of liquid through pipes, fittings, entrances and exits from chambers, etc.

. . . Friction head is expressed in equivalent vertical feet of liquid pumped. (See Fig. 3, in the lecture on "Hydraulics")

(8) Velocity head: Height to which water would rise freely at any point due to kinetic energy or energy of motion at that point.

. . . Velocity head is equivalent to the distance a mass of water would have to fall in order to attain the velocity which exists at that point. (See Figs. 2 and 3 in the lecture on "Hydraulics")

. . . Total head at any point in a pipe line equals the gage pressure plus the velocity head.

2. SYSTEM

a. *System friction curve:* Graphical representation of the relation of friction head loss in a distribution system and the capacity of the system. (Fig. 2)

(1) Friction head loss varies roughly as the square of the capacity flow through the system.

(2) Friction losses as determined are approximation at best.

b. *System head curve:* Graphical representation of capacity of the system plotted against the head which results from the combination of friction head, static heads, and difference in pressure on the system. In short, a graphical representation of the minimum head (pressure) required to maintain a given flow through a particular system.

(1) Generally, the system head curve is a sum of static head and friction heads. (Fig. 2)

(2) System head curves can be constructed for maximum and minimum static head conditions.

3. CENTRIFUGAL PUMP

a. *Characteristics:* Interrelation of capacity, head, power and efficiency of a centrifugal pump. (See Fig. 3)

b. *Capacity:* Volume of discharge in unit time under stated conditions of discharge head and speed of operation.

c. *Power:* Required power to produce given discharge under given conditions of head and efficiency, generally expressed as brake horsepower, bhp.

d. *Efficiency:* Ratio of useful work done expressed as hp, divided by the input power (bhp).

$$E = Whp/bhp$$

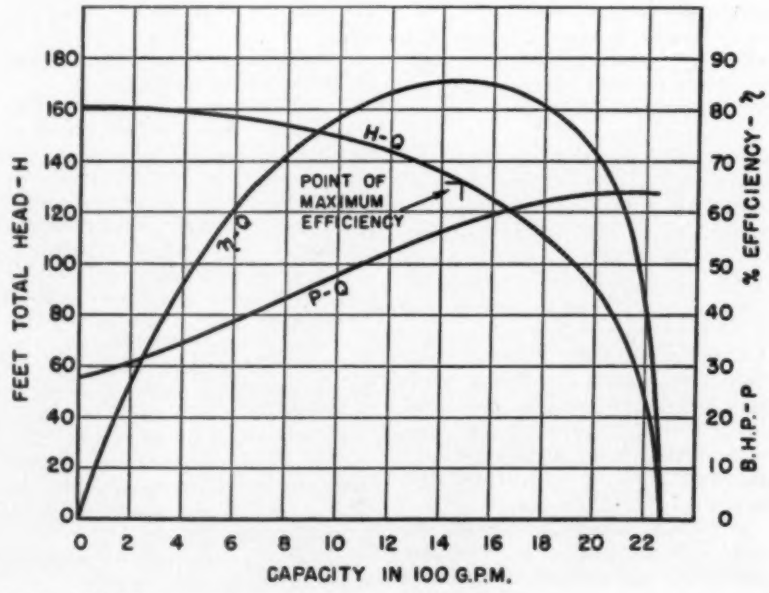
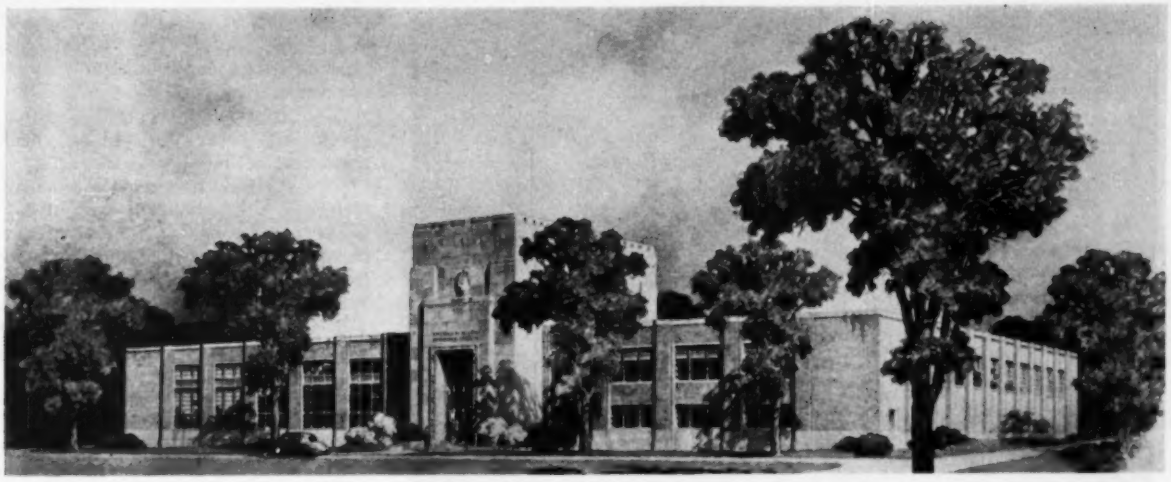


Fig. 3—PUMP Characteristic curves—Power, head, efficiency
by Carter & Karassik



MODERN pumping station—Memphis, Tenn.

(1) Useful work (called water horsepower) is the weight of liquid pumped in period of time multiplied by the head developed by the pump or

$$Whp = Q \times H \times \frac{SpG}{3960}$$

where Whp = water horsepower
Q = gpm
H = head in feet

(2) Relation of power, capacity head and efficiency is expressed as follows:

$$Bhp = \frac{P \times H}{E} \times \frac{SpG}{3960}$$

e. *Specific Speed:* Speed in rpm at which a geometrically similar pump impeller would run if it were of the size to discharge 1 gpm against a 1-ft. head.

(1) Formula for specific speed is

$$N_s = \frac{\sqrt{gpm} \times rpm}{H3/4}$$

where N_s = specific speed
H = head in feet

(2) Specific speed is the same for all pumps in the same series of geometrical design; therefore head, discharge, and pump speed at one set of conditions can be predicted from another known set of conditions.

C . . . Selection of Pumps

1. General Considerations

a. Application of pump, low service, high service, booster, well, type of fluid, proportioning, etc.

b. Source and type of power available.

c. Location of installation, available space, etc.

d. Type of pump.

(1) Vertical, horizontal.

(2) Centrifugal, reciprocating, rotary.

(3) Turbine, jet, air, etc.

2. Specific Factors

a. Capacity

(1) Total

(2) Individual pumps.

b. Suction conditions.

c. Discharge conditions.

d. System head.

e. Characteristics, head capacity, power efficiency relations.

f. Economy.

D . . . Pumping Stations

1. Buildings

a. Fireproof, attractive buildings, properly landscaped are desirable.

b. Expansion for future growth must be provided.

c. Ample interior space must be provided to house equipment and to dismantle equipment for repairs.

d. Proper heating, lighting, ventilation is essential.

2. Location

a. Location of source of supply may dictate actual location of pumping stations. Preferable location is near center of distribution system, but is seldom possible.

b. Chosen location should consider these factors:

(1) Protection of water quality.

(2) Hydraulics of distribution system.

(3) Possibilities of flood hazards, fire, etc.

(4) Availability of power.

(5) Expansion.

(6) Character of surrounding property.

(7) Economics including real estate value, operating costs, etc.

3. Equipment

a. Basic equipment will include pumps and motors.

b. Auxiliary equipment includes:

(1) Pump controls.

(2) Meters.

(3) Instrumentation.

(4) Piping, valves and controls.

(5) Surge control.

E . . . Operation

1. Packing

a. Shaft bearings in centrifugal pumps and plungers in reciprocating pumps cannot fit tightly enough to prevent leakage or friction will be too great.

b. Packing consisting of braided impregnated materials of various compositions or metalic compounds are used to prevent leakage through bearings while allowing freedom of movement.

c. Packing should not be too tight or it will cause rapid wear of piston or shaft and increase power consumption; it should be tight enough only to reduce leakage to a minimum (few drops a minute).

(1) The slight leakage lubricates the packing and prevents scoring of shaft sleeves.

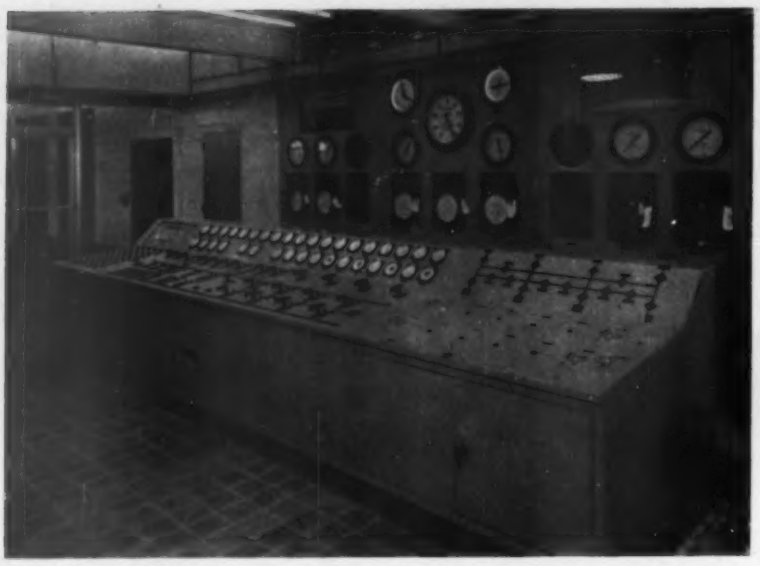
(2) If drip from stuffing boxes is objectionable the packing gland can be equipped with lantern ring and grease cup.

d. Packing is a small but important item.

(1) For general service on cold water, a long-fiber, graphited-cotton or flax is used.

(2) For hot water, graphited asbestos is used. Asbestos can be used on either hot or cold service.

(3) Metallic or other special packings are used for special service, but should never be used if the liquid contains gritty matter.



CENTRAL CONTROL station for 42 pumps—Memphis, Tenn.

2. PRIMING

a. Priming is the process of filling a pump with a water in order that it may operate. Suction line and pump case must be completely filled with water.

b. Priming may be accomplished by flooding a pump case with water from a higher head, or by vacuum on the pump case, which will allow the pump to fill under the influence of barometric pressure.

3. OPERATING PROBLEMS

a. General

(1) Noisy operation.

(2) Air leaks into pump.

(3) Packing troubles.

(4) Suction pipe and discharge line losses.

(5) Surge or water hammer.

b. Centrifugal pumps

(1) No water delivered

. . . Look for lack of prime; slow speed; discharge head too high; suction lift too high; clogged impeller; wrong rotation direction.

(2) Insufficient delivery

. . . Look for air leaks; slow speed; discharge or suction head too high; impeller partly clogged; defective impeller, wearing rings or packing; small foot valve; insufficient submergence of suction.

(3) Pressure too low

. . . Look for low speed; air in water; mechanical defects; impeller diameter too small.

(4) Intermittent operation

. . . Look for incomplete priming; too high suction lift; air leaks in suction or stuffing box; air or gas in liquid.

(5) Power requirement too great

. . . Look for head lower than rating; wrong direction of impeller rotation; packing too tight; casing distorted; misalignment.

c. Cavitation

(1) Mechanical wearing away of metal surface by action of water resulting in pitting or grooving of surface.

(2) Explanation of action

. . . Liquid leaves surface of metal guiding the water, such as pump impeller, creating a vacuum at that point.

. . . Air and water vapor are liberated into vacuum causing a bubble which collapses with an explosive effect.

. . . Repeated action wears away the metal, creates noisy operation and vibration.

d. Water Hammer

(1) Surge or water hammer in pumps and pipe lines results from starting or stopping of pumps; sudden open or closing of a valve in a pipe in which water is moving; formation of partial vacuum in a pipe and its sudden release, etc.

(2) Effect is to produce pressures above or below normal that may rupture pipe or pump case.

(3) Methods of control include fly wheel on a pump to slow starting or stopping; controlled closing and opening of valves, control of motor acceleration or deceleration; pressure relief valves; air chamber; surge tank; and surge suppressor.

e. Maintenance

(1) Pumps should be inspected, lubricated, repaired, or serviced on regular schedule.

(2) Maintenance timetable

. . . 1 month—check bearing temperature.

. . . 3 month—drain lubricant, flush bearings, refill lubricant, measure bearings for wear.

. . . 6 months—replace packing; check shaft sleeves for scoring; check alignment of pump and motor.

. . . 12 months—remove rotating element; check wearing ring clearances; remove deposits or scale; clean out water seal piping; measure total suction and discharge head; inspect all valves.

f. Replacement

(1) When the cost of operating an old pump exceeds the cost of a modern replacement, it should be replaced.

(2) Satisfactory performance with only a small loss in efficiency in an old pump may actually be expensive operation; a modern pump could be operated at less cost.

(3) Reduction in daily operation costs can often save more than enough to finance a new modern more efficient pump.

(4) If the amount saved each year plus the interest on that amount for the projected life of the old equipment equals the cost of a new pump it is time to replace.

Note: An article by C. E. Cromwell in Water & Sewage Works, October, 1954, p. 442, covers this subject fully.

F . . . References

Material for this lecture was obtained from these sources:

1. Kristal and Annett—"Pumps" (McGraw-Hill).

2. Babbitt and Doland — "Water Supply Engineering" (McGraw-Hill).

3. Carter and Karassik — "Basic Factors in Centrifugal Pump Applications" (Parts 1-6), Water & Sewage Works; 100, R-23 (May 1953).

4. Carter and Karassik — "Basic Factors in Preparing a Centrifugal Pump Inquiry" (Parts 1-3), Water & Sewage Works, 100, R-50 (May 1953).

NEXT LECTURE: The Distribution System—Part 1—Elements.

W&SW

CORRECTIONS

The following typographical errors should be corrected in previous lectures:

July, 1954—Hydraulics—p. 308, column 3, section B-2-b, paragraph 3, last two lines should read "called head in feet—2.308 ft equals 1.0 psi."

September, 1954—Flow Measurement —p. 401, section D-2-f, last paragraph, 1st col., 4th line should read $\beta = d/D$.

Electronic Tester for Large Meters

Large water meters can now be tested with accuracy and safety

by RICHARD BENNETT

Mr. Bennett, of Phoenix, Ariz., has been connected with the water departments of Tucson and Phoenix for more than twenty-five years. By profession a hydraulic engineer, he is at heart an inventor. The electronic meter tester, described in this article, is the latest of his inventions.

I OFTEN wonder if anyone has ever found a water meter-shop foreman who will not truthfully admit that his method of testing large meters is something less than satisfactory. All existing equipment and methods for testing large meters, that the writer knows of, leaves much to be desired.

Water works men have expressed the opinion, over and over, that the lack of means for *properly* testing their large meters leaves them with the feeling that these important meters are not bringing in all of the earned revenue that they should.

Taking some actual cases: One large water work, having more than 1400 meters of 3-inch size or larger (many of 12-inch size) that could not test their meters on flows larger than a 4-inch pipe stream without producing destructive water hammer on the shut-off. They had little idea of the accuracy characteristics of their meters when passing large flows. Means were not available to make exact or reliable tests in the critical flow change-over areas of compound meters. Many other water works men have complained of the same or similar conditions.

Although the large meters may account for only a small portion of total revenue, under-registration can account for a large percent of unaccounted-for water when checking metered input to the distribution system against metered sales. Efficient testing and maintenance of large meters is therefore of major importance.

It is a fact that many ignore, or passively tolerate, under-registration of their large water meters. They will make a determined effort to repair all leaks in mains as soon as they are discovered, yet will fail to adequately check their large meters at reasonable intervals for under-registration.

Something Can Now be Done About It

With the development and perfecting of the "Electronic Water Meter Tester" the water works industry now has a means of testing large water meters automatically, easily, and to a degree of accuracy never before attainable.

Unless intentional, all human errors are eliminated. The basic feature of this equipment is the elimination of *all* water hammer regardless of quantity or velocity of flow. This accomplishment opens up an unexplored field in meter testing. This tester will test flows of any magnitude or velocity electronically, with the rate of flow neither increasing nor diminishing in magnitude or velocity from beginning to end of test. Its use eliminates the vibrating effect of having to open and close valves slowly to preclude water hammer.

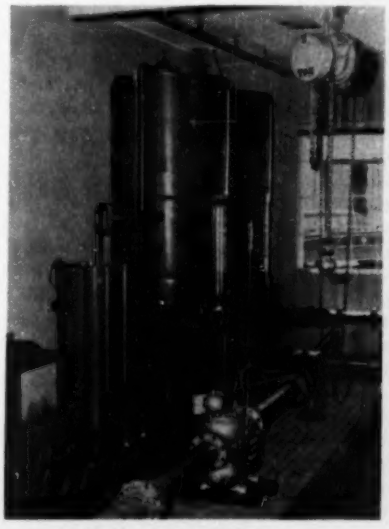
This electronic water meter tester will automatically test meters of all sizes in all ranges of flow. In the past large meters have seldom, if ever, been adequately tested except at low flows. To prevent destructive water hammer very unsatisfactory methods at high flows have had to be resorted to. Unless the test was started very slowly and throttled down very slowly at the end water hammer resulted. This practice results in a considerable registration error in the low flow register.

Means have not been available for making critical tests of compound meters, of laboratory accuracy, in the change-over areas. Such tests to be accurate, must be made at a continuous rate-of-flow in order that the low-register does not register the erroneous low flows at beginning or end, due to the necessity of slow opening or closing of the quick-closing valves. The electronic meter tester avoids such errors.

Principle of Race Track Timing Employed

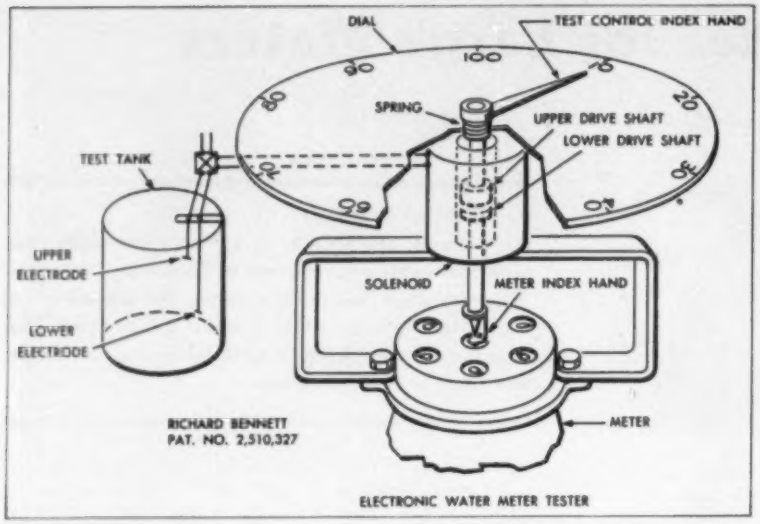
To develop the electronic tester, the principal of race track timing was employed. In order to understand this application to water meter tests imagine an automobile race track, with which an electronic timing device, not totally unsimilar to this tester, is used to determine the actual elapsed time required for the car to make one circuit of the track. The car is placed at some distance back of the starting line. It is then driven forward while being accelerated faster and faster until at the moment it crosses the starting line where the electric timing device noted the exact time. It travels at maximum speed around the track until crossing the finish line on the last lap. The electric timing device again noted the exact moment. Its rate of travel is computed and the car now begins to slow down, slower and slower, until finally it stops. The run has been completed.

The accelerating speed before the car crossed the starting line; also the retarding speed after it crossed the finish line had nothing to do with how fast the car traveled during the test run of the circuit—they were only a means to an end. This is the exact basis on which the electronic meter tester checks high flows for accuracy of registration as in the case of low flows also.



COMPOUND METER test room

Meters under test at Long Beach, Calif. with the Electronic Meter Tester.



ELECTRONIC Meter Tester showing two-piece drive shaft, and the solenoid head clamps designed to fit any meter register.

How the Electronic Meter Tester Operates

The electronic meter tester separates accuracy tests into three parts:

A—Slowly opening the main control valve of meter and permitting the flow to gradually increase in "rate of flow" until just before the actual meter accuracy test begins the water is flowing at the exact desired rate of flow into test tank. Then, the rising water touches the bottom of the lower electrode in the tank. At that moment the accuracy test actually begins — not before.

B—When the water touches the lower end of the lower electrode, an electrical impulse energizes the solenoid, bringing together the upper and lower drive shafts, thereby causing the test control index hand to revolve exactly in unison with the water meter index hand to which the tester is attached. This action continues until the water reaches the lower end of the upper electrode. During the test, the water has been flowing at one, and only one, desired rate of flow. No valves have been manipulated during the actual test period. When the water reaches the lower end of the upper electrode, the electrical circuit is broken. This causes the solenoid to be de-energized; the spring on top of the dial causes the test control index hand to instantly stop, and thus indicate the exact registration.

C—The accuracy test of the meter has now been completed; the operator can then slowly close the control valve to the meter test bench, retarding rate of flow in a manner not to create any water hammer, until the rate of flow becomes zero and before the water overflows the top of the tank.

The test, now completed in three parts, if concisely stated would be: a—Bringing up to desired rate of flow, without creating any water hammer. b—Making the actual test with electrical energy and accuracy and elimination of human errors. c—Shutting off water slowly without creating any water hammer. The water run into bottom of tank below lower electrode to secure desired rate-of-flow; also the water run into tank above lower end of upper electrode, had nothing to do with the actual test. That water was passed into the tank only as a means to an end.

There are no quick opening or quick closing valves involved, such as are required on all other meter testers—others must have these, for they measure *all* the water that passes through the meter from the time the main valve is opened until it is closed again at the end of the test. The electronic tester does not measure *all* the water that passes through the meter. It measures and registers only that portion that passes through the meter while the water is rising in the tank from the lower electrode to the upper electrode. All water passing through the meter before the test was used in accelerating the rate of flow up to the actual desired rate; all water passing through the meter after test was used in retarding the rate of flow to zero, or the shutoff point, and to prevent water hammer.

The electronic meter tester is the only tester which will indicate accuracy or registration of meters with the liquid flow being measured while operating at exactly one rate of flow after all conditions of flow have become steady.

Speed a Prime Factor

It is the only tester that will test water meters (or other liquid meters) automatically without the aid of manual control over the operation of the control valves during the actual test period. The uncertainty of the human element for accuracy is eliminated. The Electronic Tester is faster than any other known type due to elimination of the human factor; such errors oftentimes necessitate re-runs to attain even reasonable accuracy.

ELECTRONIC Meter Tester, fitted to both registers of compound meters

A prime factor with the Electronic Tester is speed of testing. It will test one, or a parallel battery, or a series of meters simultaneously. Furthermore, it will make the complete accuracy or registration test with *one* unit of water. By this is meant that with other test apparatus the index hand of the meter must pass at least ten units of liquid in order to make the test index hand make at least ten full revolutions so that an accuracy of even one-half of one per cent may be interpolated.

In other words the Electronic Tester will test approximately ten times as fast as present testers, for with this greatly enlarged dial the test results can be read to one-quarter of one per cent with only one unit of liquid passing through the test meter. This tester will give greater accuracy, and test faster than with any other known method, because of electrical accuracy and elimination of the human element. It will test all sizes with a minimum of water, thus saving testing time.

There is no re-setting to zero of meter index hands, as is required with all present types of testers, which require tedious manipulation of water through the meter in order to bring the index hand to exactly zero on the scale. This operation is not required with this apparatus — another time saver.

It accomplishes an automatic operation without aid of floats or synchronizing machinery. No floats are required in the measuring tank. An electric solenoid, or magnetic clutch, is used to determine the starting and stopping points of the test with far greater accuracy than is possible when depending on human control.

It will be noted that when it is desired to start the test, it is only necessary to manually open the main control valve of the meter and thereafter manually close the valve at the end, after the actual registration test has been performed at an acuracy rate of flow. All intermediate operations are performed automatically and water hammer elimination, not heretofore attainable, is something of the past.

In the operation of this tester the drawing shows only one meter, but it is adapted to testing any number of meters simultaneously merely by adding, for each additional meter or register to be tested, a register assembly. This feature is particularly valuable for testing meters of the compound type which have two or more registers. Heretofore this has not been possible without much guessing and imaginative interpretation to determine the register readings accurately. This tester determines such readings with an accuracy well within one-quarter of one percent, without interpretation, from the large dial. Additional meters may be of various sizes, compound meters with two or more registers in series, or parallel batteries all may be handled in the same test because there is no variation in the rate of flow during the actual test.

W&SW

Borland New Regional Manager Clay Pipe Sewer Assn.

Sherwood Borland has been appointed regional manager of the Clay Sewer Pipe Association, Inc., Columbus, Ohio, to succeed Edward W. Hartman.

Borland was employed by the Federal Government as an engineer on several projects, including National Park Service and the Tennessee Valley Authority programs. He joined the engineering staff of the City of East Cleveland in 1942 and later was associated with Wilbur Watson & Associates, Cleveland engineering firm; and Floyd Browne Associates of Marion, Ohio, as a consulting engineer. He resigned in 1948 to become city engineer of Delaware, Ohio. Borland joined the Clay Sewer Pipe Association as field representative in 1951.

Milwaukee Sues to Protect "Milorganite" Trademark

A lawsuit charging a Pennsylvania firm with trademark infringement was recently filed in the federal district court at Pittsburgh, Pa., by the Milwaukee sewerage commission.

The complaint charged that the use of "Pittorganite" for a sewage fertilizer by the Kelly Agricultural Products Co. of McKeesport, Pa., infringed upon the Milwaukee fertilizer, Milorganite, produced as a byproduct of sewage treatment here.

A Lot for Twenty-Five Cents

"The Old Farmer's Almanac" for 1955 has come to the editor's desk. As usual it is interesting from cover to cover—a lot for just a two-bit piece.

Now in its 163rd year "The Old Farmer's Almanac" has an astounding reputation for long range weather forecasting and predictions.

For the approaching winter it predicts late November blizzards and storms; for December bitter cold and some snow in second and third week, with an old fashioned White Christmas promised north of Washington; for January a severe storm in first week followed by two weeks of cruel cold, a thaw, and another storm; in February a nice blizzard during first ten days; in March another heavy snow, first week, which will rapidly melt and, with heavy rains, will cause bad floods.

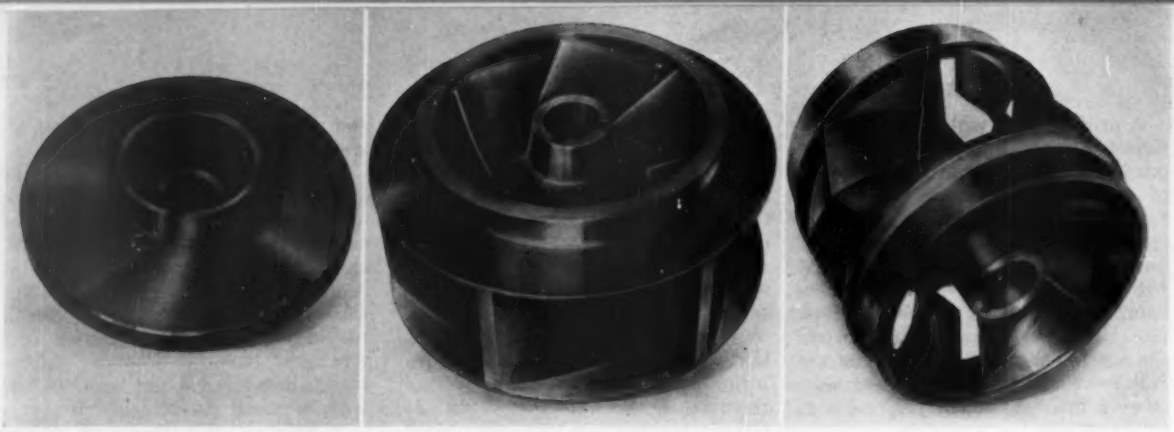
The Almanac contains tables of sunrise and sunset for every day of the year and the many other things that almanacs contain, even to "Anecdotes, Puzzles and Pleasantries," digests of "Fish and Game Laws" and "Motor Vehicle Laws" of the various states, etc., etc.

Anyway you take it, "The Old Farmer's Almanac" is a whopping twenty-five cents worth. It is on sale at newsstands, but can be ordered direct from the publisher—Yankee, Inc., Dublin, N. Hampshire.

Swingley, Indianapolis Water Co., Elected to Controllers Institute

Ralph L. Swingley, treasurer and assistant secretary, Indianapolis Water Company, Indianapolis, has been elected to membership in the Controllers Institute of America. Established in 1931, the Institute is a nonprofit organization of controllers and finance officers from all lines of business—banking, manufacturing, distribution, utilities, transportation, etc.

"So you're the reason for me not having any water pressure."



CLOSED IMPELLERS. Fig. 1—Straight-vane, single suction type. Fig. 2—Francis-vane, double suction type. Fig. 3—High specific speed francis-vane double suction type.

Designing, Constructing and Maintaining Centrifugal Pumps

Part 3—Pump Impellers

by ROY CARTER and IGOR J. KARASSIK

Mr. Carter is manager of the Volute Pump Section, and Mr. Karassik is manager of the Multistage Pump Section, Centrifugal Pump Division, Worthington Corp., Harrison, N. J. This new series has been prepared by Messrs. Carter and Karassik to review characteristics of centrifugal pumps for water and sewage service.

THE IMPELLER of a centrifugal pump is the means by which energy is imparted to the liquid. The peripheral speed of the vane tips determines the head produced by the pump.

Centrifugal Pump Impellers

On the basis of the water supply to the impeller inlet, impellers are subdivided into: (a) Single-suction impellers and (b) Double-suction impellers.

A single-suction impeller is one where the liquid pumped enters the impeller suction on one side only, while a double-suction impeller is, in effect, two single-suction impellers arranged back-to-back in a single casting, so that the liquid pumped enters the impeller simultaneously from both sides. Normally, the suction chambers located at each side of the impeller are connected to a common suction passage and a single suction nozzle.

Fig. 4—GIANT low specific speed francis-vane impeller

Relative Impeller Advantages

In the general-service, single-stage, axially-split-casing centrifugal pump design, a double-suction impeller is definitely favored. It possesses two very definite advantages: first, it is theoretically in axial hydraulic balance eliminating the necessity of an oversized thrust bearing which would always be under full load; and second, the greater suction area available in a double-suction impeller permits the pump to operate with less net absolute suction head for a given capacity than is possible with a single-suction impeller.

In small capacity units, the single-suction impeller is more practical than the double-suction for manufacturing reasons as the waterways are not divided into two very narrow passages.

In certain applications, a single-suction impeller is preferred for structural reasons. End suction pumps with single-suction over-hung impellers present certain advantages which cannot be obtained with a double-suction impeller. In general, therefore, all radially split casing pumps embody single-suction impellers. Because an overhung impeller does not require the extension of a shaft into the impeller suction eye, single-suction impellers are preferred for pumps handling liquids carrying material in suspension, such as sewage. The use of double-suction impellers involves certain shortcomings which have led to an almost universal use of single-suction impellers in multi-stage units.

Types of Impeller Vanes

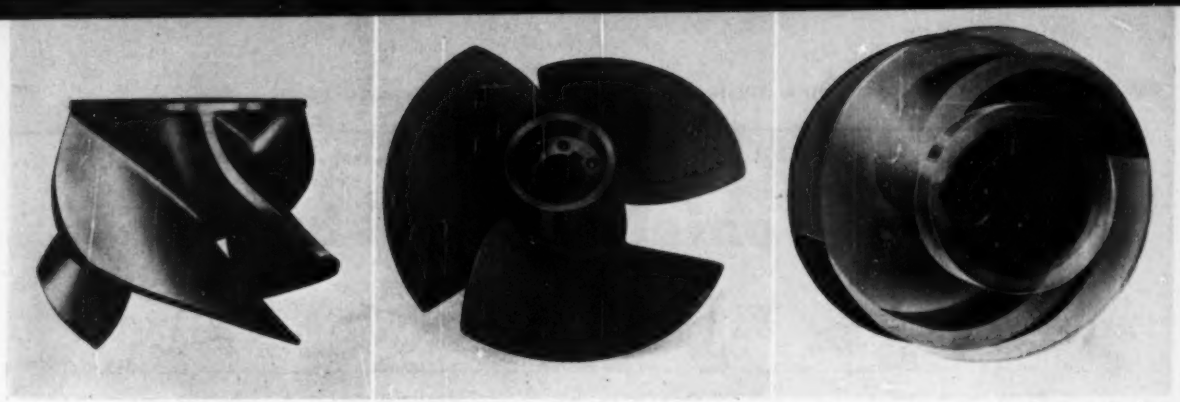
The shape or the form of the vanes employed may be used as a basis for dividing impellers into several distinctive types:

(a) The straight-vane impeller (Figs. 1 and 7).
(b) The francis-vane impeller (Figs. 2, 3 and 4).
(c) The mixed-flow impeller (Fig. 5).
(d) The propeller or axial-flow types (Fig. 6).

In a straight-vane impeller, the surfaces of the vanes are generated by straight lines parallel to the axis of rotation. Vanes of this type of impeller are also called single curvature vanes.

In a francis-vane impeller, the vane surfaces have a double curvature. This type of impeller is also often called the francis-screw-vane or screw-vane impeller.

An impeller design in which there is both a radial and axial component of flow is called a mixed-flow impeller. It is generally restricted to single suction designs having a specific speed above 4200. Lower specific speed types are called francis-vane types. Mixed-flow



MORE IMPELLERS. Fig. 5—Open mixed-flow type. Fig. 6—Axial-flow type. Fig. 7—Radial-vane non-clogging type (phantom view).

impellers having a very small radial flow component are generally classified as propellers.

A true propeller or axial-flow impeller is one having a flow solely in the direction of the axis of rotation, in other words, strictly axially.

Impeller Profile vs. Specific Speed

The profile of an impeller is definitely an indication of its specific speed as is indicated in Fig. 12. Any classification of impellers according to their profile or vane shape is naturally arbitrary, inasmuch as there is much overlapping in the types of impellers used in the different types of pumps.

Small and medium size double-suction pumps may have impellers with vanes extending across the suction eye, giving a mixed flow at the impeller entrance to meet the requirement of low pick-up losses at high rotative speeds, but the discharge portion of the impeller follows the straight vane principle.

Larger double-suction pumps operating against low heads have impellers with double-curvature vanes extended over the full vane development, and have, therefore, full francis-type impellers. The mixed-flow impeller, which usually is a single-suction type, is essentially one-half of a double-suction extreme francis vane impeller.

Design Based on Duty

In addition, there are a great number of impellers specifically designed for particular duty. As an example, for handling liquids containing rags, stringy materials and solids (such as sewage), the conventional impeller design with sharp vane edges and restricted areas is not suitable because it will become clogged. Special designs with blunt edges and large waterways have been developed and are known as non-clogging impellers. Such an impeller is shown in Fig. 7. For pumps up to 12 to 16-in. in size, these impellers are made with only two vanes. With larger pump sizes, three or four vanes generally are used.

Impellers also are classified as to their mechanical construction, such as a completely open impeller, a semi-open impeller and a closed impeller.

The Open Impeller

Strictly speaking an open impeller consists of vanes only, attached to a central hub for mounting on the shaft without any form of a side wall or shroud. With long vanes this is structurally weak and the vanes have to be strengthened by ribs or a partial shroud. Generally, open impellers are used for small inexpensive pumps or for pumps handling abrasive liquids in which the impeller rotates between two side plates, between the casing walls of the volute, or between the stuffing box head and the suction head. Because of the clearance between the blades or vanes of the impeller and the side walls, there is a certain amount of water slippage, similar to the slip in a reciprocating pump. This slippage increases as wear increases the clearance between the impeller and the stationary side plate. To restore the original efficiency it is necessary to replace both the impeller and the side plate, a much larger expense than involved for closed impeller pumps where simple rings form the leakage joint.

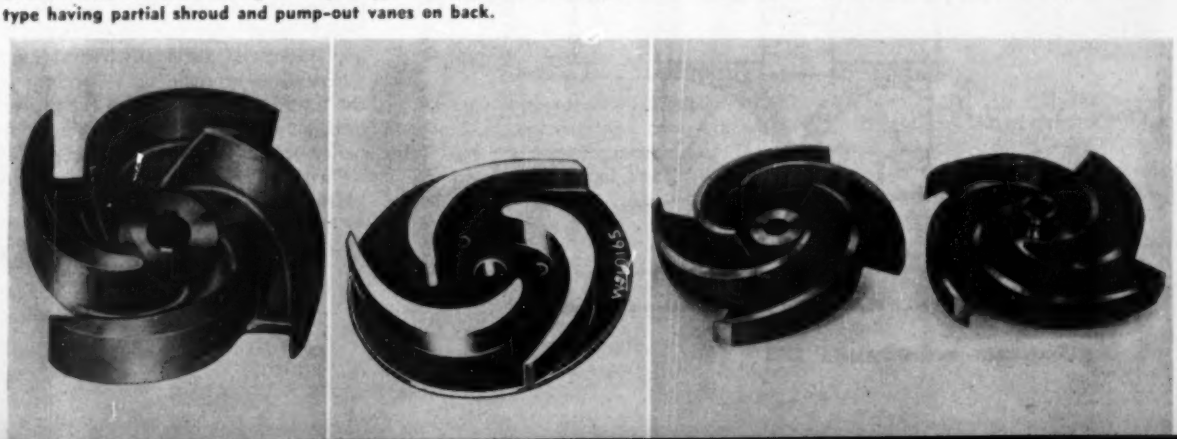
The Semi-Open Impeller

The semi-open impeller has a shroud, or an impeller backwall. This shroud may or may not have pump-out vanes, which are vanes located at the back of the impeller shroud and their function is to reduce the pressure at the back hub of the impeller. An additional feature of the pump-out vanes is that (when handling liquids containing suspended foreign matter) these vanes prevent foreign matter from lodging back of the impeller and interfering with the proper operation of the pump and of the stuffing box.

The Closed Impeller

The closed impeller, which is almost universally used in centrifugal pumps handling clear liquids, has shrouds or enclosing side walls, thus forming totally enclosed waterways in the impeller—from the suction eye to the periphery. While the closed impeller prevents the slippage of water that oc-

STILL MORE IMPELLERS. Fig. 8—Open type with partial shroud. Fig. 9—Semi-open type. Fig. 10—Front and back views of open type having partial shroud and pump-out vanes on back.



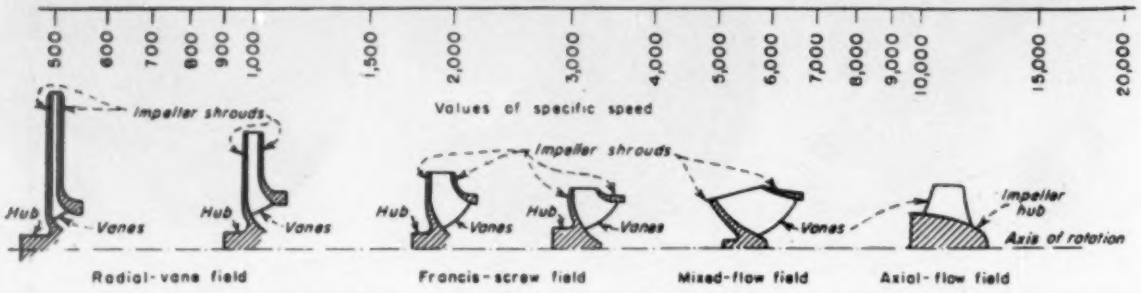


Fig. 12—IMPELLER PROFILE variation with specific speed, and approximate range of specific speed for types of impellers.

curs between an open or semi-open impeller and its side plates, a running joint must be provided between the impeller and the casing to separate the discharge and suction chambers in the pump. This running joint is generally formed by a relatively short cylindrical surface on the impeller shroud rotating within a slightly larger stationary cylindrical surface. By making one or both surfaces renewable, the leakage joint can be renewed when wear causes the leakage to become excessive.

Definition of Terms

If the pump shaft terminates at the impeller and the impeller is supported by bearings on one side only, the impeller is called an over-hung impeller. This type of construction is most advantageously used for end-suction pumps with single-suction impellers.

The inlet of an impeller just preceding the section at which the vanes start is called the suction eye. In a closed impeller pump the suction eye diameter is taken as the smallest diameter of the shroud. In determining the area of the suction eye, the area occupied by the impeller shaft hub is deducted.

By definition, a hub is the central, usually cylindrical, part of a wheel. In the case of a centrifugal pump impeller the term should be applied to one part of the impeller only; that is, to the central part of the impeller which generally is bored out to receive the pump shaft. The term, however, is also frequently used for that part of the impeller which rotates within the casing fit or within the casing wearing ring, in which case reference is made to the "outer impeller hub" or to the "wearing ring hub of the shroud".

Maintenance of Impellers

In discussing the maintenance of impellers, we will exclude maintenance relating to the wearing ring hub or the impeller wearing ring as that phase will be discussed under the subject of wearing rings.

Most pumps in water work service have bronze impellers. Bronze impellers handling treated water have long life. Occasionally such pumps are operated on high lifts or at part capacities and impeller life is affected. Such situations require consultation with the manufacturer to see if another impeller design more suitable for the actual operating conditions can be obtained.

Those pumps in water works service which pump water containing sand may have bronze, cast-iron, nickel-cast-iron or even chrome-steel impellers depending upon the amount of sand, its abrasiveness and the character of the water itself.

Generally it is desired to use an impeller material which will form a protective coating or film that adheres firmly to the underlying metal and is not washed off by the stream of water. The presence of abrasive material in the water naturally erodes such protective films on many metals, thus making their use undesirable.

In small pumps, wear on an impeller is best corrected by replacing the impeller by a new one—as the size does not permit rebuilding the impeller vanes. In some larger sizes, rebuilding by brazing, soldering, welding, etc. is feasible; however, the cost is high and replacement of the entire impeller is better. Most large size impellers can be kept in service for many years (even when abrasive material is present in the liquid) by building up the eroded areas in some manner. Any rebuilt impeller should of course be carefully balanced before the pump is reassembled.

W&SW

(Part 3 in a Series)

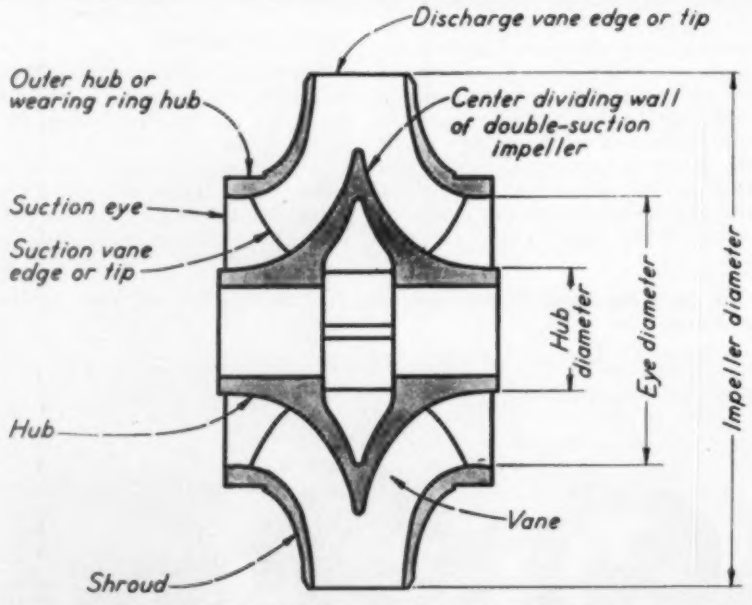


Fig. 11—IDENTIFICATION of parts, double-suction impeller.

N.E.W.W.A. Holds 73rd Convention At Poland Spring, Maine

THE New England Water Works Assn. held its 1954 annual convention at Poland Spring House, Poland Spring, Maine, October 3-6. Both the technical program and social events matched the high standards set by past meetings of this organization.

It was announced that the 1955 convention will be held on September 18-22 at the Lake Placid Club, Lake Placid, N. Y.

New Officers

To serve the association for the coming year, the following officers were elected:

President — Roger G. Oakman, Supt., Water & Sewer Div., Needham, Mass.

First Vice-Pres. — Allan F. McAlary, Supt. and Treas., Camden & Rockland Water Co., Rockland, Me.

Second Vice-Pres. — Edward L. Tracy, Dir. San. Eng. Div., State Health Dept., Burlington, Vt.

New Director—Clarence Ahlgren, Manchester Water Works, Manchester, Vt.

Treasurer — William P. Melley, Water Comm., Milton, Mass.

Secretary — Joseph C. Knox, Sec'y., N. E. Interstate Polln. Control Comm., Boston, Mass.

Editor—George C. Houser, Editor, Jour. N.E.W.W.A., Brookline, Mass.

Technical Program

The four technical sessions included one devoted to a report on water works salaries and a panel discussion of electrical equipment maintenance. The papers presented in other sessions covered a wide and interesting variety of topics.

Honors and Awards

At the association's banquet, the following presentations were made:

The Dexter Brackett Memorial Medal—to H. F. Cronin, honorary member of the association, Chief Engr. of the London (England) Metropolitan Water Board, for his paper "Some Aspects of the Water Supply to London."

President
Roger G. Oakman

Vice-Presidents
Allan F. McAlary
Edward L. Tracy

Director
Clarence Ahlgren

Secretary
Joseph C. Knox

New Program Chmn.
Kenneth F. Knowlton

Award Comm. Chmn.
Harold B. Scales

Brackett Medal
H. F. Cronin

Commemorative Award
Richard Hazen

Entertainment Chmn.
Herbert B. Crowell

Ladies Ent. Chmn.
Mrs. J. Porter Hennings

Asst. Secy. NEWWA
Mrs. Alice Melrose

The Commemorative Award — to Richard Hazen, Cons. Engr., Hazen and Sawyer, New York, N. Y., for his paper "Pumps and Pumping Stations."

Social Events

Beginning with the buffet supper, an informal get-together, there were no dull moments. An old fashioned barn dance was sponsored by the Water & Sewage Works Manufacturers Assn., which also presented an evening vaudeville show and the annual banquet. In addition, members were taken on a scenic tour to Paris Hill, there was a golf tournament for men, and special entertainment for the ladies.

Rate Formulas for Industrial Wastes

Charges for industrial wastes in municipal sewage systems utilize several methods and basic formulas

by JAMES M. SYMONS

Mr. Symons is a graduate student in sanitary engineering at Massachusetts Institute of Technology.

In this article, he reviews the four general methods of determining special charges for industrial wastes discharged to municipal sewage systems. These methods have specific advantages and disadvantages which are clearly evaluated.

ONE METHOD of abating stream pollution by industrial wastes is to discharge the wastes to city sewers for treatment and disposal with domestic sewage. The practice raises two fundamental questions: 1. What untoward effects will industrial wastes have on the operation of a municipal sewage treatment plant? 2. How shall an industry be charged for the treatment of wastes discharged into a city sewer system?

As more and more industries are required to use municipal disposal systems[1] the first problem becomes more important. This fact was indicated by a survey[2] which showed that 100 municipalities, of about 600 reporting from 30 states, experience troubles caused by industrial wastes in municipal sewage treatment works. The second problem (that of charges) has been attacked in four general ways, all of which can be reduced to basic formulas which are presented in this article.

Theory of Sewage Services Charges

Sewage service charges (sometimes termed or misnamed sewer rentals) are now in effect in one-third of the municipalities of this country with populations over 5000[3]. Such charges are based on the theory that persons who use or have the benefit of sewage treatment should be charged for that service in relation to the benefits enjoyed. Application of this theory to industrial wastes is not simple.

Many municipalities favor charging industry for sewage service whether or not the industry uses the sewer system[4]. Others feel that a fundamental basis for charge should be established. Some industries assume that the municipal taxes which they pay as property owners should cover their fair share of the cost of waste disposal. In many cases, this assumption simply is not so.

The sensible approach to the problem of payment is to take into account the matters of usage and of benefit received. On the basis of volume alone, many industries use the sewerage system out of proportion to their assessed valuation, but this is not the only consideration involved. The strength and nature of the waste must be taken into account. Table 1 shows the wide variation in industrial waste as compared to domestic sewage.

Many industries discharge wastes that are difficult to treat, and a municipality must provide special treatment over and above what would be required for domestic sewage. Since industrial wastes generally are stronger per unit volume than domestic wastes, the logic of special charges is apparent. For these reasons, a rate system should be established which measures the use and benefit derived from a sewer system and which charges accordingly[5].

Perhaps a less obvious reason for establishing an equitable rate is to promote good cooperation between industry and municipality. Exorbitant rates to an industry will result in non-cooperation on the part of industry; non-cooperation may take the form of false analysis of waste, failure to ease the burden on the system, and failure to notify the city when unusual conditions occur requiring special steps at the treatment works[6].

What should these special rates cover and how should they be determined? Most authors agree that such charges should cover operational costs, maintenance, and replacements; others favor the inclusion of fixed debt service costs, as well. There are four general methods of determining special charges for industrial wastes and each of these can be reduced to a formula. These are the "Flat Rate Formula," the "Quality-Quantity Formula," the "California Formula," and the "Joint Committee Formula."

Flat Rate Formula

The Flat Rate Formula is based on some cost per unit; i.e., unit of production, floor space, volume of waste, water used, time, or type of industry. The general Flat Rate Formula is:

$$D = (R)\ (N) \qquad (Eq.\ 1)$$

Where D = Charge in Dollars
R = Rate per Unit
N = Number of Units

Examples of the Flat Rate Formula are:[9]

Renton, Wash.—per 100 workers, $2.50 per mo
Kennewick, Wash.—Canneries, food processing plants and grape juice plants, $20.00 per mo
Clarkson, Wash.—Industrial plants, all types, $3.00-5.00 per mo
Chelalis, Wash.—Industrial plants, all types, 50% of water bill ($1.35 per month min.)
Detroit, Mich.[8]—Industrial plants, all types, $0.25 per 1,000 cu. ft. per mo

There are several advantages to using this type of charge. It has the longest precedent and may be more acceptable than any other to the parties concerned. It is easy to calculate and apply. A small city with only one or two industrial plants would find it unprofitable to conduct an extensive survey of industrial washes in order to establish a complex set of rates that would require frequent sampling. They have neither the staff nor the equipment to manage such a method. It is more feasible to determine to which unit the waste is proportional and charge accordingly.

Once the flat rate charge has been established there is no complex bookkeeping, no expensive sampling; the industry reports the necessary information (number of units, etc.), the charge is computed, and a bill is rendered.

The Flat Rate Formula is generally used in the small municipality where simplicity is the keynote. Since the flat rate charge is an approximation, at best, it is simplicity at the expense of accuracy. It neglects the nature of the waste. Flat rates are frequently based on volume, but volume alone does not measure the full

use and benefit obtained by the industry. For example, in Syracuse, N. Y., one industry has a waste with a 5-day B.O.D. of 1,000,000 ppm. That one industry could contribute a small volume but a heavy load on the treatment plant. Volume and B.O.D., likewise are not the complete measure of benefit and use. Suspended solids content and sometimes chlorine demand also must be taken into account.

Quality-Quantity Formula

In an attempt to obtain a more appropriate basis of charge, several large cities have turned to another method of computing rates, one that takes into account both concentration and volume of waste. This is the Quality-Quantity Formula, abbreviated hereafter as the Q-Q Formula. The Q-Q Formula charge is applied to wastes higher in concentration (or volume) than that considered as normal for the municipality—on the theory that these wastes impose operating costs greater than will be paid by taxes or flat rates.

Each municipality desiring to use a Q-Q Formula must develop its own, but all Q-Q Formulas stem from the basic equation, which assumes that real estate taxes and/or flat rate charges pay for fixed costs and for operation costs to treat a normal waste. The general Q-Q Formula is:

$$D = V \times R \qquad (Eq.\ 2)$$

Where D = Charge in dollars at end of billing period
V = Volume of waste discharged during billing period, expressed in units of 1000 gal, 1000 cu ft, mil gal, etc.
R = Rate in dollars per unit volume based on constituent concentration

$$R = f[aP_1(S_1 - S_s) + bP_2(O_1 - O_s) + cP_3(C_1 - C_s) + xP_4(Y_1 - Y_s)] \qquad (Eq.\ 3)$$

where S_1 = ppm suspended solids in waste
O_1 = ppm B.O.D. (5 day) of waste
C_1 = ppm chlorine demand of waste
Y_1 = ppm of other constituent
f = factor to convert ppm to lb per unit volume
a, b, c, x = factors ranging from 0.0 to 1.0 depending on local conditions and percentage of constituent excess, above a standard, for which charge is to be made.
S_s, O_s, C_s, Y_s = Standard or maximum values respectively of suspended solids, B.O.D., chlorine required and other constituents, for which no special charge is to be made above a flat rate.

TABLE 1
Comparison of Industrial Waste and Domestic Sewage

Industry	Unit of Daily Production	Volume: Gal. Unit	Volume: Pop. Equiv.[1]	5 Day B.O.D.: Ppm	5 Day B.O.D.: Pop. Equiv.[2]	Suspended Solids: Ppm	Suspended Solids: Pop. Equiv.[3]
Domestic Sewage	Per capita	127	1.0	160	1.0	187	1.0
Oil Refining	100 bbl crude oil	77,000	600	20	118	50	250
Canning Tomatoes	100 cases No. 2 cans	750	5.9	4,000	23,500	2,000	10,000
Wool Scouring	100 lbs. of goods	125	1.0	9,300	54,000	7,300	36,500
Paper Mill	1 ton of paper	39,000	306	19	106	452	2,260

1. Avg. per cap. flow = 127 gpd
2. Avg. per cap. B.O.D. = 0.17 lb per day
3. Avg. per cap. Susp. Sol. = 0.2 lb per day

P_1, P_2, P_3, P_4 = Operating costs in cents per lb for handling, treating or disposing, of respectively, suspended solids, B.O.D., chlorine required, and other constituent. Handling, treating and disposing costs may include direct operating costs, overhead, fixed costs, taxes paid by industry, etc.

If costs are based on ppm, the factor "f" is eliminated. The factors a, b, c, x, will include such considerations as the amount of constituent removed, type of treatment, etc. Factors P_1, P_2, P_3, P_4 each will include considerations of cost of power, chemicals, labor, operation, overhead, etc. and may be varied from year to year as operating costs change.

If taxes are assumed to pay for a certain allowable quantity of wastes and special charges are made only for volumes in excess of that quantity, then the basic Q-Q Formula becomes:

$$D = (V_1 - V_s) \times R \qquad (Eq.\ 4)$$

where V = Vol. of waste
V_s = Vol. allowed without special charge

The values of waste volume and strength may be determined by tests and analyses regularly, periodically, or from single observations. The values of "standard" strengths, below which no special charge is made, may be set arbitrarily or determined from average analyses of the normal dry weather flow of domestic sewage of the community.

The "Buffalo" Formula

The first Q-Q Formula used in this country, generally called the "Buffalo" formula, was developed by Symons and Crane in 1942[9]. Only primary treatment and disinfection are used at the Buffalo sewage treatment plant, and B.O.D. removal is not important because of the dilution provided by the Niagara River. Therefore, this formula contains only the factors of suspended solids and chlorine required, as follows:

$$R = f[P_3(C_1 - C_s) + P_1(S_1 - S_s)] \qquad (Eq.\ 5)$$

Where R = Rate of special charge in cents/1000 cu ft of waste volume.
P_3 = Contract price of chlorine, cents/lb.
C_s = Normal dry weather chlorine demand (ppm) of raw sewage received at treatment works (5.6 ppm).
P_1 = Cost in cents of chemicals for sludge conditioning and of power for solids disposal resulting from 1 lb. of suspended solids received in raw sewage at treatment works. (This factor includes consideration of suspended solids actually removed.)
S_s = Normal grit-free suspended solids of raw sewage as received at treatment works, (157 ppm)
f, C_1 and S_1 are as defined under the basic formula.

The factor P_3 may vary from year to year according to the contract price for chlorine; and the factor P_1 may vary according to the price of chemicals and power involved in the disposal of solids, as determined from operations for the previous year or previous two years. The values "C_1" and "S_1" may be established by analysis (periodic or otherwise) to obtain average concentrations to be

applied for any length of time. In this formula, "a" and "c" are unity, and "b" and "x" are zero.

The special charges amounted to 0.136 cents for each ppm of chlorine demand, and 0.00305 cents for each ppm of suspended solids content, both per 1000 cu. ft. of waste produced. When the charge was less than one cent per 1000 cu. ft., it was neglected. Such factors as the effect of dilution or the possible reaction of an industrial waste with the normal sewage were neglected when the formula was derived but have since been applied.

New Brunswick Usage

Another application of this Q-Q Formula is that used at New Brunswick, N. J.,[10] where

$$D = V[22 + 8.34\,(0.0025\ S_i + 0.05\ C_i)] \qquad (Eq.\ 6)$$

where V = Volume in million gallons
S_i = ppm of suspended solids (or sludge)
C_i = ppm of chlorine demand
0.0025 = cents per pound of solids
0.05 = cents per pound of chlorine demand
22 = dollars per million gallons
8.34 = f = factor to convert ppm to lb. per mil gal

In practice this formula reduces simply to:

D = $22 per mil gal—$5 per ton of sludge—$5 per 100 lb. of chlorine demand.

These charges cover only operational costs; the industries must be prepared to pay their share of any costs of plant enlargement.

Dr. Wright's Formulas

A variation of the general Q-Q Formula sets up a basic rate per unit volume (R_b) and multiplies this rate by a factor (K) based on constituent concentration wherein the constituent values, designations, and subscripts are the same as given in Equation 3 and

$$D = V \times K\,R_b \qquad (Eq.\ 7)$$

Formulas of this type were proposed by Dr. S. R. Wright[11], Head, Civil Engineering Department, University of Texas. In the Wright formulas, if primary treatment alone exists, the charge is based on suspended solids content only; Factors "b, c and x" in the basic formula (Eq. 3) are zero. If primary treatment and chlorination are used, as in Buffalo, the formula includes suspended solids content and chlorine demand, and if complete treatment exists, a charge for 5-day B.O.D. is added.

Dr. Wright assumes that only 50 per cent of the suspended solids content will be removed in a plant so factor "a" in the basic formula becomes 0.5. This type of formula applies for wastes with either excessive or deficient amounts of suspended solids content.

Dr. Wright arbitrarily sets the "standard" constituent values at 150 ppm for suspended solids and 200 ppm for B.O.D., and he gathers cost data into a single factor "R_1" which he terms the ratio of the annual cost of treatment to the annual cost of the entire system.

For primary treatment alone, the Wright formula becomes

$$K = [1 + 0.5\ R_1 \frac{(S_i - 150)}{150}] \qquad (Eq.\ 8)$$

For complete treatment without chlorination, allowing that one-third of the B.O.D. is removed by primary treatment, Dr. Wright's formula is

$$K = 1 + 0.5\ R_1 \frac{(S_i - 150)}{150} + R_1 \frac{(B.O.D. - 200)}{300} \qquad (Eq.\ 9)$$

Allegheny County Formula

A more complex Q-Q Formula of the $D = V \times KR_b$ type is the Allegheny County formula[12]. The County charges a step-wise flat rate for all wastes except those which exceed the arbitrary "standard waste." The standard waste has a suspended solids content of 275 ppm, a 5-day B.O.D. of 300 ppm, and a certain chlorine demand standard, (undetermined at the time of writing). Reduced to an equation the Allegheny formula becomes:

$$K = 1 + R_s[0.75(S_i - S_s)/S_s + 0.25(O_i - O_s)/O_s + fP_s\,(C_i - C_s)] \qquad (Eq.\ 10)$$

where R_s = Ratio of Quality Cost to Total Annual Cost = 0.15
S_s = Avg. suspended solids of all sewage (275 ppm)
O_s = Avg. B.O.D. of all sewage (300 ppm)
C_s = Avg. chlorine demand of all sewage (?)
P_s = Contract price of chlorine in cents per pound.
All other terms are as defined under the general formula.

Belleville, Ill., Application

Another Q-Q Formula of the $D = V \times KR_b$ type is that adopted by Belleville, Ill.,[13] where the premise is that waste production is exactly proportional to water usage as long as the waste does not exceed 200 ppm of B.O.D. In this formula, charges are made on a step-wise percentage of the water bill, with an extra charge made for wastes exceeding 200 ppm B.O.D. The formula reduces to:

$$D = [1 + 0.002(O_i - 200)]R_b \qquad (Eq.\ 11)$$

where D = Charge per 100 cu ft of water used
R_b = Basic rate per 100 cu ft of water used
O_i = ppm B.O.D. of waste

Additional Q-Q Formulas

Since these several various applications of the Q-Q Formula were first summarized and reviewed in WATER & SEWAGE WORKS in April, 1951[14], some 26 additional communities have adopted some form of the Q-Q Formula. They apply this to industrial wastes which are higher in quantity and in concentration, and which cost more to treat than diluted industrial wastes which are less costly to treat. One example is Madison, Wis., where users pay 20 to 50 per cent as a surcharge above the normal bill if the sewage contains a specified degree of pollution; the pollution is measured in terms of stated chemical and bacteriological factors.

The Q-Q Formula method of determining a sewer service charge will give a municipality a fairly accurate picture of how much use and benefit a particular industry is receiving from the sewer system and therefore what the charge should be.

Advantages and Disadvantages

Advantages of the Q-Q Formula are that once an equitable formula for a particular district has been developed, it is easy to apply; the charge can be computed with reasonable accuracy for each industry; and its equitable application promotes good municipality-industry cooperation. Samples are taken of industrial plant effluent, the necessary tests run, the formula applied, the charges computed, and a bill rendered.

One disadvantage of the Q-Q Formula is the problem of developing the formula on an equitable basis. Decisions must be made as follows:

1. What should be the value of the factors a, b, c, x?
2. What strength waste should be taken as a standard: the average strength at the sewage works, as at Buffalo where it includes all industrial wastes in the sewage plus domestic wastes; the average strength of domestic sewage alone; or some arbitrary strength, as in the Allegheny County equation?
3. Should the price of chlorine and

other chemicals and other specific items be included?

4. How often should samples be taken?

5. How often should the factors be reviewed?

These are questions that must be answered by the local engineer.

A second disadvantage is that Q-Q Formula applies only to one region. An equation derived for one city can not be applied in another. Each locality must develop its own equation, an unfortunate situation since many municipalities may not have the talent required to obtain an equitable formula.

A third disadvantage is the large amount of sampling and testing that must be done to supply the data needed for the computation of charges.

In spite of the disadvantages, the Q-Q Formula method has its place: a city that can afford the technicians needed for the required sampling and testing is likely to have an engineering staff that can assemble the amount of data connected with deriving a formula.

California Formula

In an effort to overcome one inherent fault of the Q-Q Formulas, that of being for local application only, the California Sewage Works Assn.[15] recommends that each municipality examine the Flat Rate and Q-Q Formulas and apply the formula most appropriate.

If neither formula seems applicable, two alternatives are suggested. Either no charges are made, or a formula can be used that charges for the additional cost of treatment of the industrial waste while taking into account any taxes paid. Thus the municipality has four possible approaches to its problem of establishing an industrial waste rate.

The combined consideration of cost of treating the waste and of taxes paid produces the "California Formula," as follows:

$$D = M - (S - s) = M - S(1 - t/T) \qquad (Eq.\ 12)$$

where D = Extra cost assessed to industry
T = All taxes paid to municipality, exclusive of industry
t = Taxes paid by industry
S = Cost of operating sewage works, before industry contributes waste, paid by T
s = Industry's share of sewage operation costs, without industrial wastes added, paid by t and s = St/T
M = Cost of operating sewage works with industrial wastes added.

Joint Committee Formula

A fourth method has been devised for the computation of sewage service rates; it is known as the Joint Committee Formula, hereafter abbreviated as the "J-C Formula." This was developed by a Joint Group of 24 members, consisting basically of committees of the American Society of Civil Engineers and of the Section of the Municipal Law of the American Bar Association, with representation of six other organizations including the Federation of Sewage and Industrial Waste Assns.[16,17]

The basic difference between the J-C Formula and other formulas for raising annual revenues is that the Joint Committee believed it unfair to charge only users for the entire cost, which is a fundamental tenet of Flat Rate, Q-Q, or California formulas. The Joint Committee theory is to charge some of the costs to non-users, i.e. property.

To quote from the Committee report, "The needed total annual revenue of a water or sewage works shall be contributed by users and non-users (or by users and properties) for whose use, need, and benefit the facilities of the works were provided, approximately in proportion to the cost of providing the use and the benefits of the works."

The charges are computed as follows: The sewage works system is divided into two parts: 1. collection system and 2. treatment plant. The revenue requirements for these units are also divided in two parts: 1. operation, maintenance, and replacement costs, and 2. fixed charges. The proportion of these two costs to be borne by users and by properties must be determined for each part of the system (collection and treatment). Surface and subsurface drainage is chargeable to property since it has no relation to use. Also provision for future capacity in any element of the system is charged to property since the additional capacity is provided to allow the development of the property. This charge will decrease and become zero as the design date of the structure is reached. When the total charge to properties has been determined, it is possible to derive a schedule of tax rates based on area, front footage, or assessed valuation, that will supply the revenue needed.

Costs chargeable to users for the collection system and treatment plant are determined from a consideration of the design factors of the structures and equipment used. In short, these design factors consider how much of each structure or equipment is necessary for treatment of B.O.D., suspended solids, or volume. (It is assumed that the chlorine demand is proportional to the 5-day B.O.D. and is not an additional factor. This is not necessarily true in all cases.)

The total costs chargeable to users for each design factor is determined and a rate schedule for that factor derived. Thus the user's charge for a particular industry is computed on the basis of an analysis of the industrial waste.

To be specific, the method reduces to this formula:

$$D = \frac{(F + O) \times (A)}{(f + o) \times (V_1)} + \qquad (Eq.\ 13)$$

where D = Charge in dollars
F = Total fixed cost of the sewage works (collection and treatment) chargeable to property divided by the total assessed valuation of the municipality.
O = Total operating, replacement, and maintenance cost of the sewage works chargeable to property divided by the total assessed valuation of the municipality.
A = Assessed valuation of the industry.
f = Total fixed cost of the sewage works per unit volume chargeable to users.
o = Total operating, replacement, and maintenance cost of the sewage works per unit volume chargeable to users.
V_1 = Volume of waste produced by the industry.

The factors F, O, f, o consist of the following elements:

$$F = \frac{(w)(I) + (x)(B) + (y)(S) + (z)(V)}{\text{Assessed valuation of municipality}}$$

$$O = \frac{(a)(I_1) + (b)(B_1) + (c)(S_1) + (d)(V_1)}{\text{Assessed valuation of municipality}}$$

$$f = \frac{(100-w)(I) + (100-z)(V)}{\text{1000 gal. waste per year}} + \frac{(100-x)(B)}{\text{lb. B.O.D. per year}} \times \frac{\text{lb. B.O.D.}}{\text{1000 gal. waste}} + \left(\frac{(100-y)(S)}{\text{lb. susp. slds. per yr.}} \times \frac{\text{lb. susp. solids}}{\text{1000 gal. of waste}} \right)$$

$$o = \frac{(100-a)(r)(I_1) + (100-d)(V_1)}{\text{1000 gal. of waste per year}} + \left(\frac{(100-b)(B_1)}{\text{lb. B.O.D. per year}} \times \frac{\text{lb. B.O.D.}}{\text{1000 gal. of waste}} \right) \left(\frac{(100-a)(s)(I_1) + (100-c)(S_1)}{\text{lb. of susp. solids per yr.}} \times \frac{\text{lb. of susp. solids}}{\text{1000 gal. of waste}} \right)$$

TABLE 2

A—Fixed Costs

Structure, Equipment or Operation	Total Cost	Portion Affected by Volume	Portion Affected by Suspended Solids	Portion Affected by B.O.D.
	Dollars per Year	Dollars per Year	Dollars per Year	Dollars per Year
Collection System	35,000	35,000		
Main Pump Station:				
Equipment	1,500	1,500		
Structures	1,250	1,250		
Screen and Grit Chamber	1,500	1,000	500	
Prim. Sed. Tanks	4,500	3,500	1,000	
Trickling Filters	30,000	5,000		25,000
Final Sed. Tanks	9,000	4,500		4,500
Recirculation Pumps	750			750
Chlorine Tanks and Equipment	2,000	500		1,500
Dig. Tanks and Vac. Filters	8,000		8,000	
Main Control Building	7,500	2,000	500	5,000
Plant Water Supply	2,500	750	250	1,500
Roads and Grounds	2,500	750	750	1,500
Plumbing and Heating	4,000	1,000	500	2,500
Total	110,000	56,750	11,000	42,250
		—35,000*		
		21,750		

B—Operating, Replacement and Maintenance Costs

Collection System	2,200	1,500	700	
Main Pump Station	9,200	9,200		
Primary Treatment	6,700	3,350	3,350	
Secondary Treatment	13,500	3,500		10,000
Effluent Chlorination	5,200	700		4,500
Sludge Disposal	17,500		17,500	
General	5,000	1,000	3,000	1,000
Supervisory	6,200	950	4,000	1,250
Collection and Billing	5,000	500	3,500	1,000
Total	70,500	20,700	32,050	17,750
		—1,500*	—700*	
		19,200	31,350	

*Collection system

Where

w = Per cent of Collection system (Intercepter Sewer and Lift Stations) fixed cost chargeable to property.

I = Total Collection system fixed cost.

x = Per cent of fixed cost of items affected by B.O.D. where items are structures, equipment, and operations, chargeable to property.

B = Total fixed cost of items affected by B.O.D.

y = Per cent of fixed cost of items affected by Suspended Solids, chargeable to property.

S = Total fixed cost of items affected by Suspended Solids.

z = Per cent of fixed costs of items affected by Volume, chargeable to property.

V = Total fixed cost of items affected by Volume, exclusive of Collection system.

a = Per cent of operating, replacement, and maintenance cost of the Collection system, chargeable to property.

I_1 = Total operating, replacement, and maintenance cost of Collection system.

b = Per cent of operating, replacement, and maintenance cost of items affected by B.O.D., chargeable to property.

B_1 = Total operating, replacement, and maintenance cost of items affected by B.O.D.

c = Per cent of operating, replacement, and maintenance costs of items affected by Suspended Solids, chargeable to property.

S_1 = Total operating, replacement, and maintenance cost of items affected by Suspended Solids, exclusive of Collection system.

d = Per cent of operating, replacement, and maintenance cost of items affected by Volume, chargeable to property.

V_1 = Total operating, replacement, and maintenance cost of items affected by Volume, exclusive of Collection system.

r = Per cent of operating, replacement, and maintenance cost of Collection system affected by Volume, chargeable to users.

s = Per cent of operating, replacement, and maintenance cost of Collection system affected by Suspended Solids, chargeable to users.

Note:

(100 — per cent chargeable to property) = per cent chargeable to users.

To apply the formula, the factors w, x, y, z, a, b, c, d, r, and s must be estimated and each item (i.e. structures, equipment, and operations) in the system must be examined to decide how much of the fixed, operating, replacement, and maintenance costs may be charged against volume, B.O.D. loading, and suspended solids.

J-C Formula Example

In the example illustrated in Table 2 the assessed value of the municipality is assumed to be $20,000,000, the yearly sewage flow 1,370,000,000 gallons (1,370,000 thousand gallons), the yearly B.O.D. load 3,874,000 lb. and the yearly suspended solids load 3,647,000 lb.

The various factors in the formula reduce to:

Estimated	*From Table 2*
w — 64.0%	I — $35,000
x — 28.2%	B — 42,250
y — 31.7%	S — 11,000
z — 40.5%	V — 21,750
a — 60.0%	I_1 — 2,200
b — 30.0%	B_1 — 17,750
c — 30.0%	S_1 — 31,350
d — 40.0%	V_1 — 19,200
r — 79.5%	
s — 20.5%	

Applying these factors to the J-C Formula, the calculation becomes:

$$F = \frac{[(0.64)\ (35{,}000) + (0.282)\ (42{,}250) + (0.317)\ (11{,}000) + (0.405)\ (21{,}750)]}{20{,}000{,}000}$$

= $46,580/20,000 = $2.329 per $1000 of assessed valuation

$$O = \frac{[(0.60)\ (2{,}200) + (0.30)\ (17{,}750) + (0.30)\ (31{,}350) + (0.40)\ (19{,}200)]}{\$20{,}000{,}000}$$

= $23,740 per 20,000 = $1.187 per $1000 of assessed valuation

Total tax rate—$3.516 per $1000 of assessed valuation.

Assume:

300 ppm B.O.D. = 2.5 lb./1000 gal.

250 ppm Susp. Solids = 2.08 lb./1000 gal.

Therefore:

$$f = \frac{[1.00 - 0.64)\ (35{,}000) + (1.000 - 0.405)\ (21{,}750)]}{1{,}370{,}000} + \frac{(1.00 - 0.282)\ (42{,}250)}{3{,}874{,}000} \times 2.5 +$$

$$\frac{(1.00-0.317)\,(11{,}000)}{3{,}647{,}000}\times 2.08$$

= $0.0186 per 1000 gal. + $0.0196 per 1000 gal. + $0.0043 per 1000 gal.
= $0.0425 per 1000 gal.

And:

$$o=\left\{\frac{[(1.00-0.60)\,(0.795)\,(2{,}200)+(1.00-0.40)\,(19{,}200)]}{1{,}370{,}000}\right\}+\left\{\frac{(1.00-0.30)\,(17{,}570)}{3{,}874{,}000}\times 2.5\right\}+\left\{\frac{[(1.00-0.60)\,(0.205)\,(2{,}200)+(1.00-0.30)\,(31{,}350)]}{3{,}647{,}000}\times 2.08\right\}$$

= $0.0089 per 1000 gal. + $0.0080 per 1000 gal. + $0.0126 per 1000 gal.
= $0.0295 per 1000 gal.

Total volume rate = $0.0425 + $0.0295 = $0.0720 per 1000 gallons of waste produced. Substituting in the original formula:

$$D=(F+O)\times(A)+(f+o)\times(V)$$

D = ($3.516 per $1000) × (A) + ($0.0720 per 1000 gal.) × (V)

Where:

A = Assessed valuation of the industry
V = Volume of industrial waste produced.

Advantages and Disadvantages

One advantage of the J-C Formula is that it is completely fair. It examines each component of the sewer system and treatment works critically and determines what portion of its fixed costs, operational costs, and maintenance costs should be charged to the various categories. The cost of future capacity is added and reduced periodically as the design date of the structure is approached. The J-C Formula is most equitable and it should appeal both to municipalities and industry.

Disadvantages of the J-C Formula are the exacting method with which each structure must be examined, the decisions that must be made in relation to the percentage of each item to be charged to each category, the bookkeeping involved to determine a rate for tax assessment and a rate for volume, the 5-day B.O.D. load, the suspended solids content, and other factors.

After the rates have been established, the sampling necessary to maintain the procedure is expensive. The cost may be as high as $40 to $80 per day of sampling and testing. Two days of sampling and testing per year (taken as a minimum) might cost the city 30 per cent of the assessed charge for some small industries.

The Joint Committee suggests a remedy. Assuming two days of sampling and testing as a minimum, and a cost of five per cent of the yearly income from industry as a maximum, a "standard waste" may be established below which no sampling will be done. The standard may be set as a certain volume per day, a certain suspended solids content, or a certain 5-day B.O.D. load, although the latter two might encourage dilution with cooling water to meet the standard. Such a dilution procedure would penalize an industry on a volume basis but perhaps not in the same proportion.

Another problem is the variation of the future capacity factor. If this factor is to be fair it must decrease with the passage of time. This is complicated, however, since the whole sewerage system must be reviewed each time a change is to be made. Three to ten year intervals have been suggested for review, depending on the growth of the community. Once the basic facts are at hand, however, complications can be kept at a minimum.

The J-C Formula is more difficult to administer than the Q-Q Formula, but has its place, particularly in the large industrial city which has staff and money available and which needs an accurate method of charging industry for use and benefit of the sewage works system. Obviously the J-C Formula is more accurate than the flat rate or Q-Q formulas.

Summary

The problem of disposal of industrial wastes is growing so rapidly that if treatment in the municipal plant is the answer, as it seems to be, industries should be charged for the use and benefit derived from the municipal sewage system.

Several formulas are available for determining equitable charges. Each has its specialized realm of application: The Flat Rate Formula in small municipalities with very few industries; the Q-Q Formula in larger cities, needing a more accurate charge basis due to more industries and more complex wastes; and the California Formula or the J-C Formula in large industrial cities where accurate and equitable charge bases are essential.

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W&SW

The Practice of Sanitation Published in New Edition

A revised and expanded second edition of "The Practice of Sanitation", by E. S. Hopkins and W. H. Schulze, has been published by the Williams & Wilkins Co., Baltimore, Md.

This book is designed as a beginning text on the many aspects of environmental sanitation which should be of value to teachers, health departments, and leaders in civic activities. There are 464 pages and 131 figures. Price of the book is $8.00.

Annual Water and Sewage Conferences Held at State College, Pa.

The 27th year for the Water Works Operators' Association and the 28th for the Sewage and Wastes Association.

A TOTAL of more than 600 members and guests attended conferences of the Pa. Water Works Operators' Association and of the Pa. Sewage and Industrial Wastes Assn. at State College during the week of August 23, 1954.

The water conference registration was 345, of which number 85 were ladies. The sewage and wastes conference registration was 284, of which 47 were ladies.

Next year's conference will be held during the week of August 22nd.

Water Operators' Conference

A full program of technical sessions and social events was offered in the three-day meeting of the P.W.W.O.A., August 23-25.

New Officers

To serve for the coming year, the following officers were elected:

President—V. F. Rigling, Div. Mgr., Amer. W. W. Service Co., Harrisburg

Past Pres.—B. F. Johnson, Chemist and Bacteriologist, City Water Co., New Castle

First Vice-Pres.—S. P. McBride, Gen. Mgr., Trotter Water Co., Uniontown

Second Vice-Pres.—John O. Fulmer, City Chemist, Easton

Secretary-Treas.—R. R. Kountz, Prof. of San Engr., State Univ., State College

Awards Winners

The association presented the following awards:

To R. P. Ferringer, Commissioner, Water Dept., Brookville, the *President's Award* for his paper on European Water Plants.

To Harry J. Krum, Bureau of Water, Allentown, the *I. M. Glace Award* for his many contributions to the improved operation of water treatment plants.

Social Events

An important social event on the program was an "Ox Roast Dinner" served at the University summer surveying camp. There were two golf tournaments, with prizes for the winning players.

For the ladies, there was an outstanding luncheon and special matinee at the Standing Stone Theatre.

Sewage and Wastes Conference

The Sewage and Industrial Wastes Assn. also offered a three-day program, August 25-27, immediately following the water works operators' conference.

New Officers

This association elected the following officers for the coming year:

President — Gordon J. Wiest, Research Director, Warner Lime Co., Devault

P.W.W.O. Assn.

President
V. F. Rigling

First V.P.
S. P. McBride

Second V.P.
John O. Fulmer

Secretary-Treas.
R. R. Kountz

President's Award
R. P. Ferringer

Glace Award
Harry J. Krum

P.S.&I.W. Assn.

President
Gordon J. Wiest

First V.P.
Lewis L. Gwin

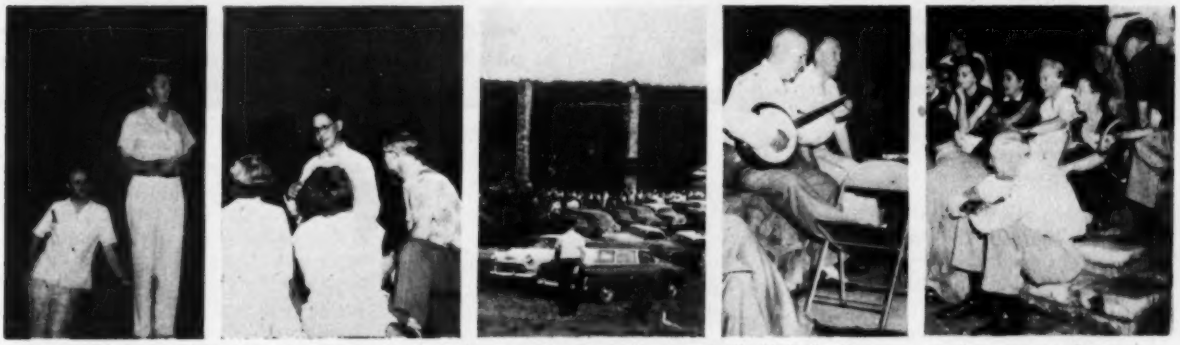
Second V.P.
George Elias

Secretary-Treas.
Bernard S. Bush

Director
H. T. Reuning

Editor
J. R. Hoffert

WORK BY DAY—Panel discussion, L. S. Duckworth presiding; operator speaking, Reg. Adams; President Johnson and Secretary Kountz.



PLAY AT NIGHT—Golf prizes awarded by A. I. Andrews; visitor from Jamaica, L. P. McFarland; scenes at the ox roast dinner.

First Vice-Pres. — Lewis L. Gwin, Professional Engr., Altoona
Second Vice-Pres. — George Elias, Dist. Engr., State Health Dept., Philadelphia
Director—H. T. Reuning, Engr., N. Y. and Pa. Co., Ridgway
Editor — J. R. Hoffert, Chief Engr., State Health Dept., Harrisburg
Secretary-Treas. — Bernard S. Bush, Dist. Engr., State Health Dept., Wilkes-Barre

Technical Program

Technical sessions included a sewage operators' round table, an industrial wastes symposium, discussions of air diffusion experiences, of the acceptability of industrial wastes into public sewerage systems, and of plant maintenance. In the last session papers were presented on these topics: effect of garbage on sewage treatment, economics of home garbage grinding, and the administrative control of stream digester operation.

Social Events

Among the social events on this program were the golf tournament, and the annual association dinner. For the ladies there was a bus trip and a guided tour of Penn's Cave.

Double Celebration For "Vic" Bengle, 70-49

Veteran salesman for Chapman Valve Co. of Indian Orchard, Mass., Victor Bengle heard many attending the NEWWA Convention at Poland Spring, Me., on Oct. 5th, sing "Happy Birthday to You!"

The inquisitive reporter, in checking up, was surprised to learn that Bengle had reached his 70th birthday on Oct. 5th. Further questioning disclosed the fact that on Oct. 1, '54, "Vic" Bengle began his 49th year with the same company—Chapman Valve.

We think our readers, looking at the accompanying snap-shot, will agree that "Vic" Bengle is 70 years young. Apparently his company heads have the same impression and are to be commended for not having retired a still very active and productive member of the Chapman sales staff.

Practice vs. Theory

Daily, I grow to honor *facts* more and more; *theory* less and less.—*Carlyle.*

A great many "open minds" (so-called) should be closed for repairs.

It almost always pays to do a little better than seems necessary.

Jacob Rubbo Dies

Jacob Rubbo, superintendent of the

Iron Mountain, Mich. water filtration plant, died on September 7th. Mr. Rubbo, aged 48, was at work within the plant when death occurred.

Mr. Rubbo had long been an active member of the Michigan Section A.W.W.A., and was among the pioneer users of free residual chlorination to improve the quality of water supplies.

Stabilization of Polluted Waters

Basic factors involved are the organisms, the food, and the environment

Part 1—The Organisms

by H. HEUKELEKIAN

Dr. Heukelekian is Professor of Research Eng., Agr. Expt. Sta., Rutgers Univ., New Brunswick, N. J. In this paper, he reviews fundamental principles in the stabilization of domestic sewage, industrial wastes, or mixtures of the two. His discussion applies to changes taking place in biological treatment plants or in receiving streams.

THE biological stabilization of pollutional materials is basically dependent upon bacteria, protozoa, fungi, and algae. It is the vital activities of these organisms, rather than their mere presence, that determines the biochemical stabilization of pollutional materials. The problem can be formulated as the action of the proper organisms on the food under proper environmental conditions.

Activity = organisms + food + environmental conditions

It is the purpose of this discussion to explore critically the status of basic knowledge regarding the activities of microorganisms as influenced by three factors—the organism, food and environmental conditions—and to suggest areas where additional information is needed. By understanding these factors, activities can be manipulated to obtain greater efficiency in the stabilization of pollution.

Organisms

The organisms must be present for biochemical stabilization of pollutional material. Organisms are ubiquitous, however, and most polluted waters are infected by a variety of microorganisms.

There are certain exceptional wastes which have a dearth of microorganisms. Such wastes may arise either from sterile processes or where an attempt has been made to keep down the microbial population by disinfection procedures. The natural occurrence of certain disinfecting chemicals also may cause a low microbial population level. If germicidal chemicals are not or cannot be dissipated or neutralized, then the hope of establishing a microbial population for the stabilization of pollutional material by biochemical methods is doomed to failure.

After measures have been taken to dissipate, neutralize, or remove the germicidal agents, such substrates may require seeding in order to furnish the microbial population; then as a result of their proliferation, the proper flora and fauna will become established. Given enough time, such substrates initially devoid of microbial life could develop the population from accidental contamination from air or equipment because of the ubiquitous nature of microorganisms. This phenomenon was the origin of the old idea of spontaneous generation.

How many microorganisms are required to bring about an expeditious stabilization of pollutional material? It is not possible to give a numerical value to this query for the following reasons: (1) It is doubtful whether cultural methods employed in enumerating bacteria include the organisms responsible for the stabilization of pollutional material, and hence the mere enumeration of a large number of bacteria may be entirely misleading; (2) it is believed that there is a relationship between the bacterial level established and the food concentration; and (3) even if it were possible to count the organisms responsible for stabilization, a high population level may not necessarily indicate a high level of activity.

Population and Multiplication

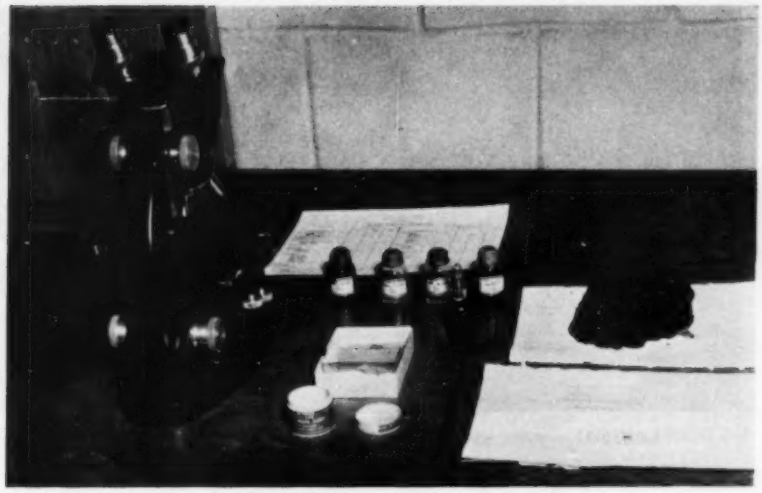
It has been demonstrated that the maximum rate of utilization of food is not necessarily associated with the maximum population level at the stationary phase, but during the active logarithmic phase of multiplication. This relationship has been established by Butterfield and Purdy for oxygen utilization rate and bacterial numbers in dilute peptone-dextrose solutions. More recently Buswell and his collaborators have established the same relationship for nitrification, namely that the rate of oxygen uptake in the oxidation of ammonia to nitrite is directly related to the multiplication of nitrosomonas.

Therefore, multiplication rather than high population level is the significant factor. It is possible under certain conditions to obtain a high rate of activity with low observed populations actively multiplying, and low activity with a high stationary population level. But the multiplication rate (generation time) for all microorganisms even under optimum conditions is not the same. The generation time for some bacteria under optimum conditions may vary from as low as 15 to 20 minutes for *E. coli*, up to 6 to 9 hours, and even up to 31 hours as Buswell found for nitrosomonas.

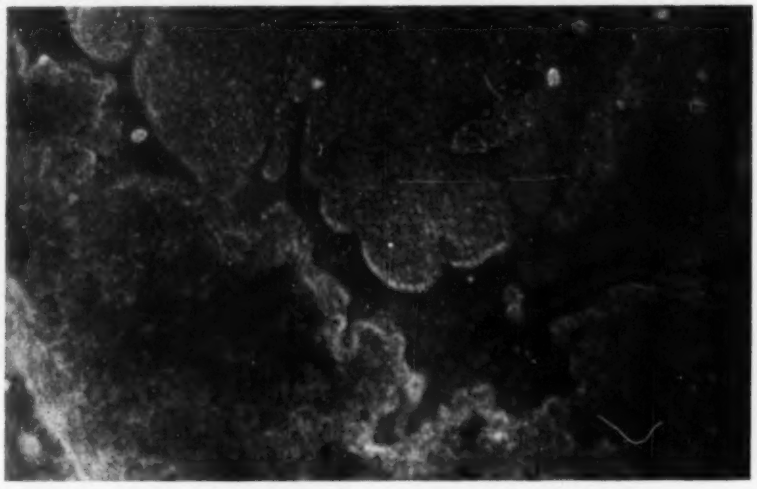
It follows from this that certain microbiological reactions are inherently slow even under ideal conditions. Therefore, in order to obtain the maximum amount of change in a minimum time, great numbers of organisms must be present and actively multiplying. This is the explanation for the slow rate of nitrification of diluted or undiluted sewage under aerobic conditions (10 to 12 days), while nitrification in activated sludge and trickling filters takes place in a matter of hours.

The same explanation applies to methane fermentation. Although no information is available as to the generation time of methane bacteria, it is believed to be quite long; it is known that large quantities of seed are required for methane fermentation and a long period of time is needed to establish it in raw sludge.

Microorganisms generally grow as individually dispersed cells. Certain bacteria grow in small chains and in other group forms. With this type of growth, depending upon the food concentration and environmental conditions, a maximum density of population is established which cannot be exceeded. To increase the number of organisms, greater volumes of treated



EQUIPMENT for microscopic identification of organisms in filter slime



FILTER SLIME, a microbial aggregate which increases rate of stabilization

material must be retained or returned to reach the maximum rate of stabilization of waste.

Increasing Stabilization Rate

The formation of greater microbial aggregates by floc, slime or film growths affords a means of increasing the rate of stabilization of wastes by simply increasing the density of organisms per unit volume. This is simply and automatically accomplished by furnishing the organisms some contact surface on which microbial aggregation can take place. The surface may be crushed stone, gravel, slag, coal, coke, limestone, Rashig rings, etc. Aggregation takes place on trickling filters (or on suspended matter in the waste itself), in the activated sludge process. A bothersome slime formation often takes place upon submerged surfaces such as concrete, wood, asbestos, glass, pipes, tanks and other structures. The establishment of such growths generally is associated with aerobic conditions, although attached submerged growths occur in sewer conduits and streams under conditions which are not strictly aerobic.

The discussion of organisms has been presented from the standpoint of numbers alone, and has led us to the conclusion that numbers as such are insignificant in respect to rate of transformations, unless related to the rate of multiplication. In turn, the rate is related to generation time, and there are inherent differences in the generation time of different microorganisms. For a given organism, the generation time and hence the rate of activity can be manipulated and accelerated by changing the environmental conditions.

Types of Organisms

The discussion now will be directed toward types of organisms. There are hundreds of thousands of different species of bacteria alone. There also is a great variety of fungi, protozoa, and algae. It is accepted that the ultimate and expeditious stabilization of pollutional material is dependent on proper integration of various species of all of these groups of microbes, each fitting into a certain section of the chain of reaction; each type plays its role at the proper time and place (as do the different instruments in an orchestra playing a symphony) and then retiring after its role is accomplished and giving way to the other types.

The picture is one of the pulsation of a great number of species, and all the pulsations comprise a uniform, harmonious and unbroken level. It follows that to try to accomplish stabilization by means of a single species of organism is a forlorn hope: the complex nature of the food materials in the wastes make this impossible. In addition, the greater the complexity of the flora and fauna, the more expeditious and complete the stabilization. This was established in 1931 by Butterfield and Purdy.

Once this generalization is made, however, it is not possible to state what organisms are involved in these chain reactions and what role each plays in the various parts of the chain. At present, it is impossible to effect a control over the organisms beyond letting nature take its course and aiding the establishment of an unknown population by manipulating environmental conditions.

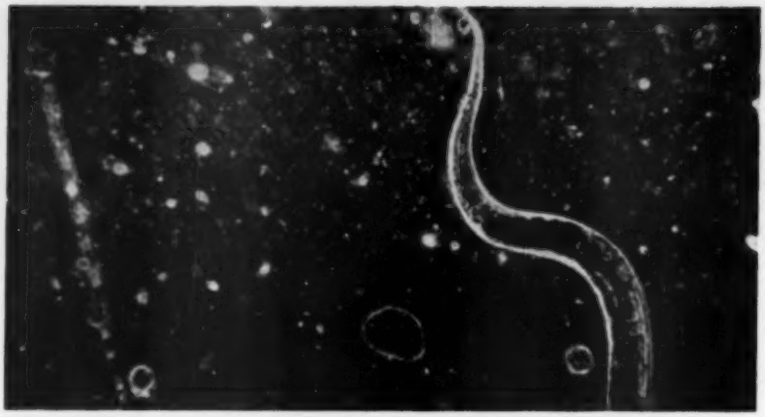
The fact that a single limited number of species cannot bring about stabilization is not to be attributed to an eclecticism on the part of microorganisms. It is true that some of them are quite rigid in their food requirements and cannot multiply unless a certain compound is present. But these are the exceptions. The majority of microorganisms are quite catholic and omnivorous in their food habits; some, like *Pseudomonas putida*, can utilize 200 different organic compounds. Some compounds can be utilized by a great number of different species, and there seems to be at least one organism capable of utilizing all known natural organic compounds and many pure synthetic compounds. It is easier to cite the compounds that cannot be utilized than those that can.

Predominant Organisms

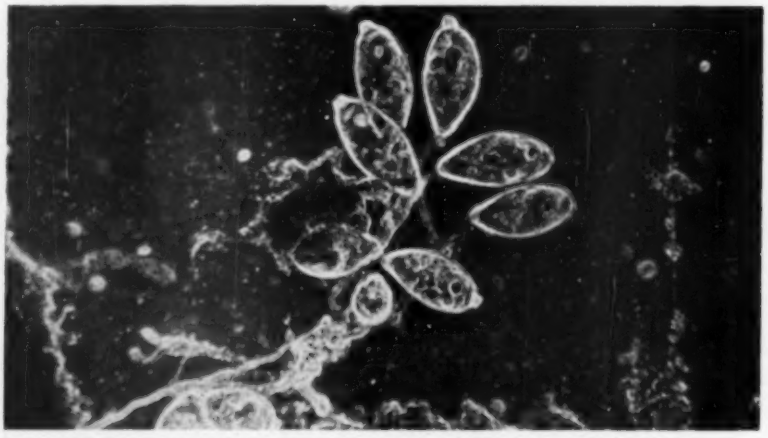
When a number of different organ-

isms can utilize the same compound or substrate, what determines which type actually gains predominance over the others? One of the factors that contributes to this could readily be the generation time. If one organism multiplies more rapidly than another, then it has a distinct advantage in competing for the food and starving out the slower growing organism.

We also are completely ignorant as to the types of populations in those biological processes treating different types of wastes. For instance, we term all aeration processes utilizing recirculation of flocculent growths "activated sludge," whether they treat sewage, dairy wastes, chemical, or pharmaceutical wastes. There is a great probability that the organisms involved are entirely different. The same applies to trickling filters and digestion processes. Activated sludge and trickling filters should be considered as generic names embracing a number of different types and varieties.



MICROORGANISMS—round worm, flagellate protozoa, bacteria and fungi



POPULATION—colonial cilliates, bacteria and branched colonies of zoogles

Effect of Environment

The two ways whereby a population establishes itself in a given waste under specific conditions, are by selection and mutation. In a contaminated substrate such as sewage (containing a great variety but relatively few numbers of microorganisms) for a given environmental condition and food supply, a population establishes itself most importantly by a process of selection. Certain species finding the conditions favorable for their development, multiply, gain ascendance, and become the predominant forms at the expense of other forms. This is referred to as a process of natural selection.

Mutations also are possible although we have no bonafide evidence of their occurrence in waste treatment processes. Mutations are of two types, natural or spontaneous mutations, and induced mutations. Spontaneous mutations occur at unpredictable and infrequent intervals. Mutations also may be induced artifically as a result of response to chemical and physical stimuli, such as radiations. True mutations of both kinds are those that give rise to new varieties of microorganism in the progeny of a pure culture of a single cell, with physiological and morphological characteristics different from the mother cell, and which breed true thereafter whether or not the stimuli that gave rise to them is present.

Mutations must be differentiated from adaptation to physical and chemical environment, which is only a response to that environment as long as the conditions giving rise to them persist. Adaptations are not true mutations, but merely acquired characters which at present we believe not to be transmitted.

Each species of microorganism may be visualized as possessing many inherent and potential activities. From these the actual activities of any individual is determined by the physical and chemical conditions prevailing at the moment (like an orchestra with a wide repertoire from which a certain number of selections are played for a particular program). True mutants, spontaneous or induced, propagate themselves by natural selection, provided that the new varieties are better adapted to the surrounding environment than their progenitors.

Acclimatized Organisms

The whole process of establishment of a new population from a mixed flora and fauna, for a specific treatment process, is commonly referred to as acclimatization or adaptation. There is no specific connotation as to whether the mechanism is by natural selection from the mixed population, or by spontaneous or induced mutations.

Natural Selection Process

In waste treatment practice, this procedure is followed consciously or unconsciously whenever a new and specific treatment process is to be started for a given waste. The waste is subjected to a certain environmental condition until a population is established and the process assumes its normal operating efficiency. Deviations from this normal level of operating efficiency are ascribed to a failure to maintain the optimum environmental conditions for the established population; they reflect a change in composition and concentration of the waste, with particular reference to the presence of inimical substances. In other words, we presume an effect on the flora and fauna indirectly by the change in the efficiency.

The adaptation and acclimatization referred to have been considered from the standpoint of organic pollutional materials which in themselves have no inimical effects on the microorganisms. It is merely a question of establishing an active population by a process of selection from a mixed flora and fauna suitable for a specific waste.

A certain degree of adaptation or acclimatization can be accomplished for wastes containing toxic materials. Such materials either may be available as food for microorganisms (such as phenol formaldehyde, etc.), or may not serve as sources of food (such as copper, nickel, chromium, zinc and cyanides). There is now ample evidence that increased tolerance can be built up by a process of repeated transfers into substrates containing successively higher concentrations to both types of chemicals. There is naturally an upper limit of concentration beyond which it is impossible to build up a tolerance. This upper limit is a function of each chemical, but is influenced by the amount of organic material in the substrate, the pH value, etc. It is not known whether such adaptations are the result of natural selection or of mutations.

This normal adaptation or acclimatization, commonly referred to as a maturing of a process, is the only practice that has been used successfully and universally in waste treatment processes, as far as the author is aware. The renewed attempts to supplement this process of natural adaptation or acclimatization by the addition of biocatalysts, bacterial and enzyme preparations, is of doubtful value. No positive proof has been advanced that these can hasten the period of maturation, or that once the process is established their use improves efficiency of operation. On theoretical and practical bases their use is contraindicated for the following reasons:

(1) Microorganisms generally grow so fast that, if they are present at all (as they are in most substrates), an effective population is established rapidly, provided that optimum environmental conditions are maintained.

(2) Once the population is established, it propagates itself indefinitely as long as optimum environmental conditions are maintained. The addition of artificial cultures will have no effect under these conditions. If the natural population should suffer a set-back due to unfavorable environmental conditions, the artificial addition of cultures could not overcome the effect of the unfavorable conditions on the already established population.

(3) Since there is such a dearth of information regarding the organisms responsible for the stabilization of pollutional material, artificial cultures can at best be a hit-or-miss collection of organisms.

(4) Although certain biochemical reactions have been accomplished by enzyme preparations free of living cells, the efficiency of such reactions is not as high as similar reactions brought about in the presence of living cells because: (a) enzymes may be destroyed or deactivated, while living cells generate enzymes continuously; (b) enzyme reactions follow the law of mass action and are reversible, thus the accumulation of reaction products and the establishment of equilibrium concentrations would bring the reaction to a stop; (c) the only successful pure enzymic reactions are those concerned with exoenzymes or hydrolytic enzymes which leave the products in the substrate without complete stabilization, as a result of cellular assimilation and utilization; (d) in a substrate containing a variety of complex organic compounds, it is difficult to provide the necessary enzymes to bring about an integrated and complete degradation of all organic compounds by an arbitrary selection of enzymes; and (e) all rigidly controlled experiments to detect the value of artificial bacterial and enzyme preparations have failed to verify the claims made for them.

Competition and Other Effects

Before leaving the subject of microorganisms as a basic factor in waste treatment, it is desirable to interject another set of related phenomena, namely the question of competition, synergistic, symbiotic, and antagonistic effects. Again our information regarding these phenomena is far from definite and is primarily conjectural and general. We expect that competition between different forms of microorganisms must play a role. Competition may stem from the struggle for a limited food supply, and from the fact that certain types (due to their greater rate of multiplication) are capable of depriving slower growing forms of food.

There is also the phenomenon of predation well illustrated and documented by the work of Butterfield and Purdy in conjunction with certain bacteria-consuming protozoa. Such predation has been shown to increase the rate of stabilization by its tendency to prevent bacteria from reaching a maximum stationary level, thus keeping them in the stage of logarithmic growth.

Biological Balance

The whole concept of biological balance in the chain reactions in polluted waters is based on the synergistic and symbiotic relationships between different organisms; namely, that the presence and activity of certain organisms promotes and is essential to the activity of others. The opposite phenomenon may also be expected; namely, that the activitv of certain organisms may produce intermediate metabolic products which are inimical to the activity of other organisms. An accepted illustration of this is the production of organic acids in anaerobic digestion. What is not known is whether antagonistic products, such as antibiotics, also are produced in the waste treatment process with inimical effects on reactions.

A specific problem relating to types of organisms in connection with the B.O.D. determination of certain industrial wastes and pure compounds is worthy of consideration. In the routine determination of 5-day B.O.D., the recommended procedure of seeding the dilution water with sewage can lead to values which may not necessarily give the maximum possible oxygen demand value, as substrates of certain character may require a highly specialized flora which is not abundant in normal domestic sewage. When sewage is used for seeding such wastes and compounds, the lag period of variable duration which ensues vitiates the values obtained after a fixed 5-day incubation period.

This is a direct application to B.O.D. of the seed adaptation and acclimatization already discussed. The answer seems to be to use properly adapted seeds in such instances. Some published and other unpublished results indicate a wide divergence of results obtained in the B.O.D. of certain chemicals and wastes seeded with sewage and properly adapted seeds. Whether the B.O.D. is determined to assess the deoxygenating effects of such chemicals and wastes in the stream, or to assess the load and purification efficiency of such materials in waste treatment process, the values obtained by sewage seed can be very misleading. In streams where such wastes are discharged continuously, it may be assumed that deoxygenation is brought about by adapted flora and fauna at higher rates than would be indicated by the use of sewage seed.

(Part 1 of two articles)

W&SW

REPORT FROM ABROAD

Developments in Water Pollution Research and in Activated Sludge History

by JOHN FINCH

Mr. Finch is Manager of the Sewage Disposal Dept., Rotherham, England. In his Report from Abroad, he discusses topics and opinions of timely interest. He will welcome the opportunity of replying personally to readers of *Water & Sewage Works* who require additional information regarding subjects covered in his series.

ANNUAL reports of the British Water Pollution Research Board of the Department of Scientific and Industrial Research are fast becoming premier scientific publications in their field. The 1953 Report comprises some 60 pages of concise and pertinent facts. A notable compilation of work carried out by the comparatively small group of workers headed by Dr. B. A. Southgate, the Director of Research, and A. E. J. Pettet, the Assistant Director, it is a very worthy addition to the series.

The Chairman of the Board, Professor D. M. Newitt, states that despite the great temptation to investigate the very many problems awaiting solution, the Board thought it best to concentrate the effort available on a few projects. He points out that a thorough examination of many of the basic sewage treatment processes should be undertaken when the opportunity presents itself; for example, the efficiency of sedimentation processes of treatment might well be increased if the principles involved were better understood.

Survey studies of the River Thames Estuary still occupy a large proportion of the Board's staff. The immediate object of these studies is to provide information on which a policy for the future of the estuary can be based. Decisions must be made on the extent to which sewage and trade effluents should be purified before discharge to the estuary; on the amount by which the temperature of the estuary may be allowed to rise through the use of the water for cooling at power plants; and on the extent to which fresh water should be taken from the upper reaches of the Thames for public water supply.

Pollution by Cooling Waters

It is rather interesting to note that the influence of cooling water upon rivers has had some repercussions in Great Britain where this situation occurs on occasion in small rivers. It has been ruled by the courts that raising the temperature of the water of a stream constitutes pollution.

It is stated in the Report that the rate of heat input to the estuary from these sources, has, over the past twenty years, been increasing at an average rate, per year, of around 6.7×10^9 B.T.U. per day, and it is understood that the rate of increase during the next ten years is likely to be at least as great.

Incidentally, one of the best references on the subject of problems associated with the introduction of warm water into watercourses, is a document produced by the British Electricity Authority. This is a translation of a contribution by A. Viehl, on "Effects on Temperature on Biological Reaction in Water and Mud, with particular reference to the Action of Warm Water introduced into Water Channels." This document provides a summary of the current literature on the subject and in many ways is authoritative.

Toxic Wastes and Dissolved Oxygen

The Water Pollution Research Laboratory is carrying out investigations under controlled conditions to determine the effect on different species of fish of various constitutents of sewage effluent, and of any adverse conditions which may be brought about by the presence of that effluent in the water. An example of this work is that the important part played by a deficiency of dissolved oxygen in enhancing the effect of toxic substances, such as ammonia, is now better understood.

The Report emphasizes also the importance of the diurnal change in the concentration of dissolved oxygen, which may occur in a river containing floating and rooted vegetation; the water of such a river, when it contains small quantities of directly toxic substances, may be harmless to fish during the daytime but may be lethal at night, when the concentration of dissolved oxygen is lowest.

Distribution Rate and Filter Effluents

Referring to investigations on the periodicity of dosing of percolating filters, the Report states that it is clear this is an important factor in determining the efficiency of a filter. Further work will be carried out in an attempt to establish how this factor is related to others.

Work has been continued at the Minworth (Birmingham) treatment plant to learn the effects of periodicity of dosing on the treatment of settled sewage by alternating-double-filtration. In this investigation, four large filters are used, each 120 feet in diameter and each fitted with a rotary four-arm distributor. Average results of experiments from 1949 to 1953 suggest that, of the range of speeds examined, the optimum rate of rotation of the four-arm distributors was 1 revolution in 15 or 30 minutes. At this speed the quality of the effluents was noticeably better than was that of the effluents from filters on which the distributors were driven by the conventional reaction jets.

In investigations carried out at Finham (Coventry), it was noticed that the concentration of oxidised nitrogen in the effluents increased as the rate of rotation was reduced throughout the whole range tried.

Organisms Tolerate Cyanides

A very good chapter on the treatment of cyanides by biological processes gives some indication as to the trends in this branch of the industrial

waste field.

It was shown in the 1952 Report that the organisms responsible for the purification of sewage will, in time, tolerate the presence of quite sizeable proportions of cyanide and will destroy it as it passes through a percolating filter. It has now been demonstrated that straight cyanide solutions can be similarly treated. The results of investigations show conclusively that aqueous solutions of the cyanides of potassium, zinc, cadmium and copper commonly used in electro-plating can be partly or completely destroyed biologically in a percolating filter. Further work is to be carried out on this problem.

The Water Pollution Research Laboratory staff is doing a very fine job of work. Dr. Southgate and his team are producing results of importance in their fight against pollution, despite the fact that on occasion, through lack of facilities and shortage of staff, the Director of Research has to deploy his forces rather thinly over the terrain to be covered.

However, the year 1954 should be a milestone in the progress of the Laboratory: the new laboratory at Stevenage will be available for occupation during this year and, as staff becomes available, the onslought on the problem of pollution will be intensified.

Activated Sludge Developments

Of the nine contributions to the Blackpool symposium on the evolution and development of the activated sludge process in Great Britain, three extremely interesting papers were those by Townend; Bolton; and Vokes and Jenkins. These authors discussed "The Large Scale Application of the Diffused Air Process at Mogden Works"; "The Birth of the Simplex Process at the Bury Sewage Works"; and "Development and Application of the Partial Activated Sludge Method of Treatment at Birmingham."

In these contributions are the elements of toil and sweat, success and disappointment, and climax and anti-climax—all referring to the activated sludge process. Technical literature was never more absorbing and certainly never more honest than that presented in these papers.

Mogden Works a Rush Job

In his paper, C. B. Townend, engineer to the Middlesex County Main Drainage Department, describes how the works at Mogden were designed straight off the drawing board without the time or opportunity for experimental work of any kind, unlike the normal case of plant evolved over a period of years to suit the particular sewage concerned. The general endeavour on the part of the consultants, J. D. and D. M. Watson, was to combine the best of English, American and other practice and to improve wherever possible. Many innovations and departures from existing practice were introduced in all stages of the scheme, while calculated risks had to be taken for the sake of progress.

Since the Mogden works were opened in the year 1935, the contributing population has increased from 1,000,000 to 1,400,000 persons at the present time; the trade load may at times rise to be equivalent to an additional 500,000 persons.

Nitrification Originally Attained

The objective at Mogden always has been to establish and maintain the maximum degree of sludge activity under conditions of vigorous nitrification, and to allow the process to reach the peak of purification. Mr. Townsend states the experience at this works has shown that when the air supply is adequate to produce an optimum degree of mixing, it is also adequate for the supply of the necessary oxygen intake. He says that under these conditions, with a plant tuned to a fine point of efficiency, a difference of only 2 per cent in the air supplied will be noticed in the results obtained, indicating a most economic useage of the air.

From the operational point of view the Mogden plant has produced very good effluents. Due to the purification being extended to the point of advanced nitrification, the aeration plant has been essentially stable and capable of dealing with unusual shock loadings. Its stability is instanced by the protection which a generous return of sludge provides. The sludge contains large reserves of nitrates, especially useful when septic effluents were passed to the aeration tank in the very early days (as a result of changing over from the old works).

Nitrification Now Impossible

Mr. Townend reports, however, that in 1950 there began a steady decline in nitrification of the aeration tank effluents, and nitrification has now become almost non-existent.

This condition apparently coincided with a very considerable rise in the sewage loading along with the greatly increased use of synthetic detergents. No final conclusions have yet been reached, but it was very disturbing to the Mogden authorities to find that when an unusual decrease in the loading existed during a four-month period in the summer of 1953, and the capacity and air supply should have been much more than adequate to restore first class operating conditions, the improvement effected was insignificant.

Perhaps the most important statement in Mr. Townend's paper is that, during the last four years of operation, great difficulties of operating the process without the stability of advanced nitrification have been experienced. These have confirmed the value of operating the plant on the old basis.

Mr. Townend has given activated sludge operators much to think about, not only those in Great Britain where the statement was made, but those in the U. S. and elsewhere—wherever the Mogden experience may apply. We in Great Britain hope that he also gives the Ministry of Housing and Local Government's Detergents Committee—of which he is a member—more to think about.

Development of Mechanical Aerators

Mr. Joshua Bolton's paper describing his work and investigations into the mechanical aeration of sewage at the Bury sewage works in many respects reads like a novel. It's full of action; mistakes and setbacks in the investigations are faithfully recorded for the world to read about. Referring to the start of the work, Mr. Bolton says:

"On November 16th, 1914, the late Mr. W. H. Duckworth of Salford, supplied me with a small quantity of sludge in an active condition. It was placed in a four-litre jar with a perforated coil at the bottom for distributing the air. This was the beginning of the Bury experiments."

Mr. Bolton is a gentleman with the patience of Job. He tried diffusers; he tried nozzles; he tried mechanical aerators of a variety; he tried air-lift pumps: always attempting to attain the maximum efficiency from his pilot

Mechanical aerators are born

Mr. Bolton is a gentleman with the patience of Job. He tried diffusers; he tried nozzles; he tried mechanical aerators of a variety; he tried air-lift pumps; always attempting to obtain the maximum efficiency from his pilot plant experiment.

plant experiments. He finally considered that the cone aerator, later to bear the name of the "Simplex" cone surface aerator, was the last word in aeration mechanisms. At a later date, his son, Mr. J. F. Bolton, was to introduce the "High-Intensity" cone, and raise the standard of mechanical aeration to a new peak.

In his paper, Mr. Bolton states that, in research, mistakes or uncontrollable circumstances often have been the means of providing valuable information. He then observes that due to the cutting-off of power supplies on occasion, during the course of his investigations, his pilot plant aeration units were perforce closed down. However, this enforced stoppage had little adverse effect upon the activated sludge; upon the restoration of power supplies the sludge continued to carry out its function quite satisfactorily, after a short period of circulation.

This experience led Mr. Bolton to believe that an activated sludge plant could be installed as a booster plant in an existing works, to be operated during the daytime when the strong sewage was being dealt with, and shut down during the weak night flows. Interestingly enough, this method of treatment is still in operation at the Halifax Sewage Treatment plant.

Partial Treatment Activated Sludge

In their contribution on the partial treatment activated sludge process, Messrs. Vokes and Jenkins pay tribute to that great team of workers J. D. Watson and F. R. O'Shaughnessey; the latter studied the activated sludge process, not as a substitute for the percolating filters at Birmingham, but as a supplementary element in the treatment process by percolating filters.

So it came to pass that the activated sludge process was used in the form of a small pre-treatment plant to double the capacity of the filters and to render 43 acres of filter beds capable of dealing with a much greater load.

Such was the impact of this process upon the *percolating filter* field that, when the effluent from the first partial treatment plant of 1923 passed to the filters, it was discovered this effluent was free from colloidal solids (which clog the surface of filters), and also that it could unclog a filter already suffering from such blockage. This discovery finally lead to the operation of percolating filters by the method of alternating-double-filtration. Thus activated sludge technique, developing through a series of stages, led to the improvement of the percolating filter.

As Dr. Jenkins concludes, what greater encouragement could be offered to the originators of new ideas, than the example of this laboratory investigation? After leading to a process of sewage treatment without the aid of filters, the investigation finally resulted in the discovery of a method of improving the efficiency of percolating filters!

W&SW

Edw. S. Hopkins, Baltimore, Establishes Consulting Office

Edward Scott Hopkins has retired from his position as Principal Associate Engineer, Bureau of Water Supply, Baltimore, Md., after 35 years of service, and has announced the establishment of his office for consulting services in Sanitary Engineering. Mr. Hopkins holds the rank of Colonel in the Medical Service Corps, U.S.A.R. In 1949 he was the recipient of the Fuller Award of the A.W.W.A.

Associated with Mr. Hopkins are Harry R. Hall, retired Chief Engineer of Washington Suburban Sanitary District, and Ambrose E. McCaskey, Jr., Head, Dept. of Engineering, Marshall College. The firm will specialize in water supply, sewerage, industrial wastes, stream polution investigations, design and operational problems. Offices are at 407 Morris Bldg., 306 N. Charles St., Baltimore, Md.

Vincent Lucas Sanitary Engineer For General Electric Co.

Vincent deP. Lukas of Albany has been named sanitary engineer for the General Electric Company. Lukas will be engaged in a company-wide program regarding water supplies and waste treatment under the general direction of Kenneth S. Watson, consultant of water management and waste control.

A native of Yonkers, N. Y., Lukas studied sanitary engineering at Manhattan College where he received his bachelor's degree in 1949. His schooling was interrupted while he served as a navigator with the Eighth Air Force in the European Theater of Operations during World War II. He was a first lieutenant.

Lukas has worked with the Water Pollution Control Section, New York State Health Department, Albany, as a sanitary engineer and participated in a statewide program of stream classification and industrial waste surveys. He is a member of the American Society of Civil Engineers, and the Federation of Sewage Works Association.

William T. Ingram Establishes Consulting Practice

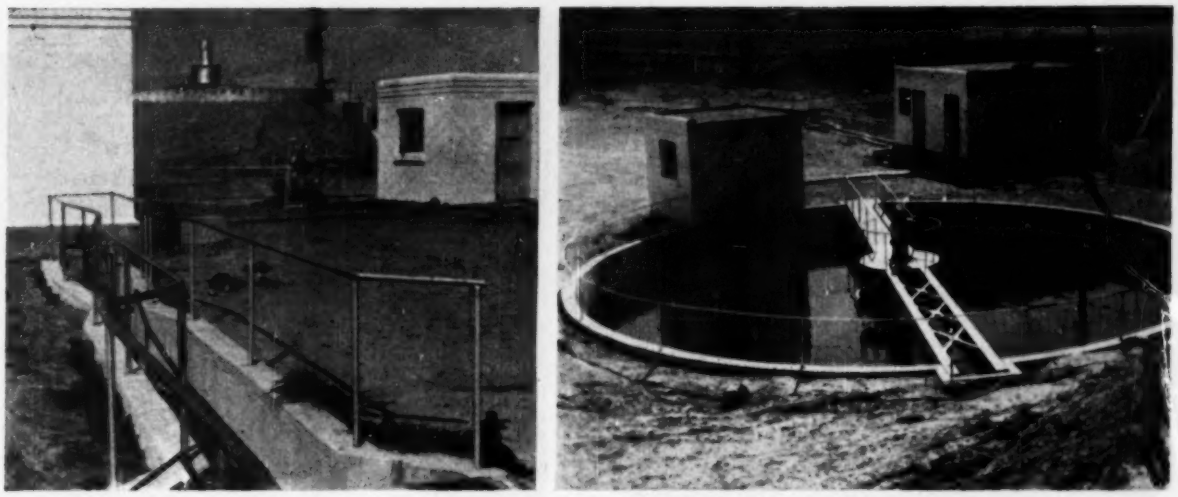
William T. Ingram has announced the establishment of a consulting practice in Sanitary Engineering in New York City. Effective September 1st, his home office will be 20 Point Crescent, Whitestone 57, New York. His laboratory office is at South Shore Laboratories, 148 Islip Avenue, Islip, Long Island, New York.

Professor Ingram will continue his association with New York University, College of Engineering, as Adjunct Professor. He will serve as a project director with the Research Division of the University on Sanitary Engineering, Industrial Health and Safety, and Air Pollution Control Research.

Mr. Ingram's practice will be directed primarily to the environmental problems of industry, including: water supply, sewage disposal, refuse disposal, air pollution control, industrial hygiene and safety, and other sanitation practices. He has twenty-three years of experience in Sanitary Engineering and Environmental Health Practice, working experience with Public Health agencies at all governmental levels, and has served as a consultant for various communities and industries.

Emile P. Leclerq Joins Consulting Engineers

The consulting engineering firm of Seelye Stevenson Value & Knecht has announced that Emile P. Leclerq has become associated with that organization. Mr. Leclerq is a specialist in water treatment, sewage disposal, and industrial wastes.



JEROME PLANT. Parshall flume with digester in background. Secondary clarifier, with primary at right rear

Operating a New Sewage Plant

JAMES K. FERRELL, the author, is Superintendent of Sewage Treatment at Jerome, Idaho. **In this article, he describes the problems of an underloaded plant and explains how they were solved.**

THE sewage treatment plant at Jerome, Idaho, was completed in June, 1952, and was put into complete operation shortly thereafter. The plant was designed by Hamilton and Voeller, Consulting Engineers, and was constructed by the Grayson Construction Company. The treatment plant is a single stage bio-filtration type of plant, using an aerofilter. This type of filter is widely used in the state of Idaho, and generally accomplishes a high degree of B.O.D. removal.

Design Data

The sewage treatment plant is designed for a population of 6,000, with only 4,500 connected at present. The plant is designed for an average flow of .96 mgd. Since it is capable of handling a flow of about 1.8 mgd, it is operating considerably under capacity.

Detention in the clarifiers at the designed flow is 1.8 hours. At present it is about 3.5 hours. The clarifier overflow rate at designed flow is 726 gpm. The aero-filter has a settled sewage basis of 1.96, and a surface loading of 14.3. The sludge digester is heated, and has a capacity of 3.92 cubic feet per capita. Recirculation of sewage effluent will be as required for satisfactory operation.

Sewage Flow

The sewage enters the plant through a 24-inch outfall sewer, then passes through a Worthington comminutor located in the Parshall flume structure. After passing through the Parshall flume, the sewage flows into a wet well, from which it is pumped to the primary clarifier with three Fairbanks Morse pumps. From the primary clarifier the sewage flows by gravity through the plant, the aero-filter, the secondary clarifier, and chlorine contact tank. Each clarifier is 45 feet in diameter, and the filter is 62 feet in diameter.

The sludge from the primary clarifier is pumped to the separate sludge digester by means of a centrifugal pump. This American Well Works type of pump has given excellent service, even when pumping the thickest sludge. The sludge digester is 45 feet in diameter and is equipped with a Pacific Flush Tank heat exchanger; the sewage gas generated in the digester is burned for heat.

The plant has been so designed that any one unit can be bypassed, or a series of units can be bypassed. In an emergency, the secondary clarifier may be used as a primary should the need arise.

The plant has a complete laboratory, and the usual control tests are run. Tests for B.O.D. and relative stability are not made, as we do not have a proper incubator for this purpose. It is expected that one will be obtained in the near future.

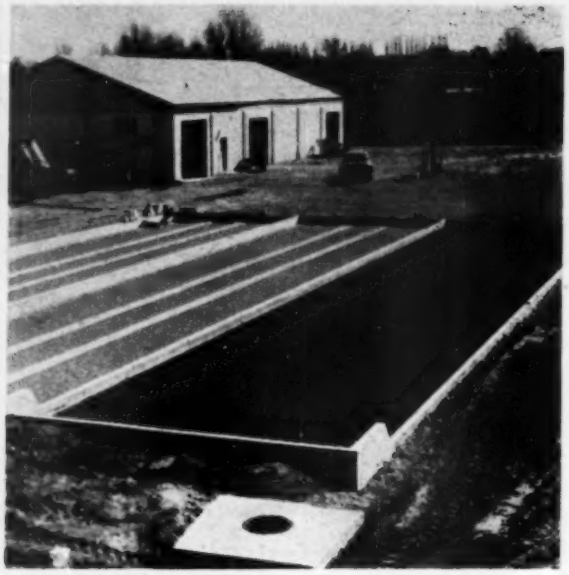
Chlorination

It has been the practice to pre-chlorinate sewage coming into the plant, as well as to add chlorine to the final effluent. This practice has proven very satisfactory, as it improves the settleability rate and reduces odors in the wet well which is located under the main building. The chlorinator is a Wallace and Tiernan MSVD unit.

Operating Problems

We have experienced a considerable amount of difficulty in keeping a good growth on the filter media. Several experiments have been tried to correct this condition, and at the present time it is thought that we have the problem solved.

As we have no recirculation pumps, the only way of recirculating sewage to the filter is drawing sewage from the secondary to the wet well, where it is mixed with raw sewage, pumped



FILTER is standard rate Aerofilter. Beyond SLUDGE DRYING BEDS are the city shops.

to the primary, and then to the filter. This has proved to be an advantage, as the secondary sewage adds dissolved oxygen to the raw sewage, and keeps it in a fresh state. Otherwise, the raw sewage going to the primary would contain no dissolved oxygen.

The main reason for recirculating effluent is to keep the filter distributors in operation at all times. At present our flow is not adequate to do this and as a result, the filter is not working properly. Pumping has been altered so that pumping is intermittent. This keeps a large amount of sewage going through the filter about every 10 minutes. The filter is a high rate filter, but we are operating it similar to a standard rate. By following this new operational procedure, we have obtained a fairly good growth on the filter media, and it is hoped that it will continue.

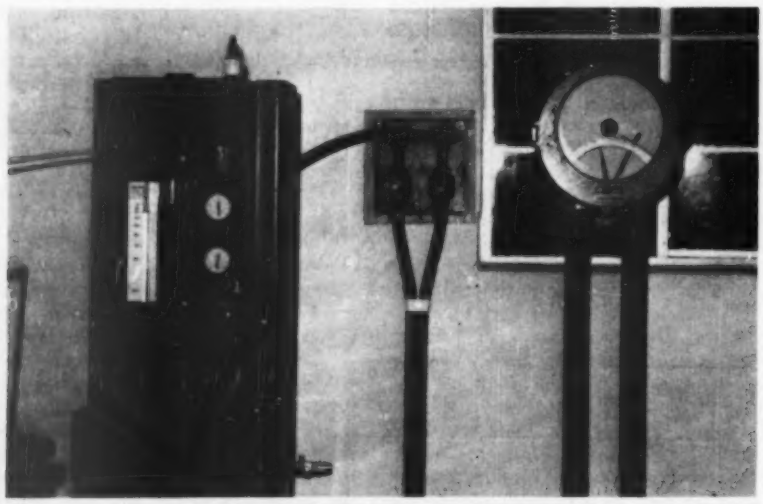
After the plant had been in operation for some time, the sludge recirculation pump in the digester gave us considerable trouble due to leakage. The sludge drained out onto the floor, and proved very unsightly. To correct this, the suction side of the pump was tapped, and a pipe was laid to a sump in the pipe gallery; the pump leakage was thus drained to the same sump, by means of a copper tube. When the sump was full, or partially full, a valve was opened, and the sludge recirculation pump removed the accumulated drainage. This has solved a problem that was very irritating to the operators.

Trouble was experienced with large boards coming into contact with the Comminutor blades. Once the blades were broken, and the motor was burned out. To prevent this from happening again, a bar screen was made and fitted in front of the Comminutor. This screen has to be manually cleaned once or twice daily.

A fence is being installed around the plant to protect the treatment units; in the past, we have had trouble with night visitors throwing rocks in the clarifiers. On one occasion the primary tank had to be pumped out and the rocks removed. The rocks fouled the collectors and broke a cast iron coupling connecting the motor to the main shaft of the collectors. The fence will no doubt solve this problem. It will also prevent tumble weeds from blowing into the treatment units. These weeds have proved very undesirable, due to their collecting around the effluent pipes during the night.

The plant site is being landscaped, and at present, is almost ready for seed. This is a project that the street department has taken over, due to the small operating staff at the plant.

It has been the practice to encourage the public to visit the plant, and to publish articles in the local paper of the happenings at the treatment works. Through this procedure, I believe that the public will become more educated on the need of cleaning up polluted rivers and streams that are present in every state. This should be a challenge to every person that works in a sewage treatment plant, so that eventually we will have clean waters.



INSIDE THE PLANT, chlorinator and flow meter.

W&SW

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Preventing Water Shortages

by L. D. MATTER

In recent years, an increasing number of our Water Authorities, Departments and Companies, have undergone a new experience — water shortage. The rapid development of fringe areas with accompanying population increases, the enormous use of water by industry and the increase in the number of air conditioning units have all played a part in this situation.

During 1953, fifty-six public water supply systems were reported to the Pennsylvania Department of Health as being dangerously low in water. Of these, twenty-six found it necessary to obtain water from auxiliary or emergency sources which they continued to use until the spring rains came in April of this year. The communities so affected ranged from 500 to 80,000 in population. In five instances the Governor was requested to declare a state of emergency.

For many years, certain communities have been on the verge of water shortages, but usually the rains came in time to save them. However, in 1953, especially in the south central section of Pennsylvania, the rains did not come, as expected, and a number of communities experienced, for the first time, serious water shortages. Already, in 1954, 23 communities have placed restrictions on water use. Five have found it necessary to develop and use new sources of supply, while 3 have resorted to the use of water from emergency sources of supply.

Pennsylvania has an average annual rainfall of 42", which, if spread over an area of 45,000 square miles, is equivalent to 33 trillion gallons of water. If all of this water could be served for public use, one year's rainfall would serve the Commonwealth for sixty-eight years. Sixty per cent of the 42" annual rainfall occurs between January and June, which leaves only 40 per cent during the last half of the year.

Mr. Matter is Asst. Chief Engineer, State Dept. of Health, Harrisburg, Pa. His paper was presented at the 27th annual conference of the Pennsylvania Water Works Operators' Assn., State College, Pa.

Surface Sources

U. S. Geological Survey data indicates that in 1951, public water supply systems in Pennsylvania delivered 1,319,000,000 gallons of water per day to their consumers, 82 per cent of the state's population. Ninety-two per cent of this water was obtained from surface sources (streams, lakes and ponds), while only 8 per cent came from underground sources. Private supplies furnished 9,409,800,000 gallons daily chiefly to industry. Of this, 95 per cent was taken from surface supplies. This indicates that only about 12 per cent is furnished by public water supplies and that 96 per cent is taken from surface sources and only 4 per cent from the underground.

In the face of these figures, we must recognize the extremely important place our surface streams occupy in our water supply program. The Schuylkill River is an outstanding example of what can be done with a grossly polluted stream through a reasonable stream pollution control program. Through the excellent cooperation of the municipalities and industries along the Schuylkill with the Sanitary Water Board in the construction of sewage and waste treatment facilities, combined with the silt dredging program of the Department of Forests and Waters, this stream has been transformed from an open sewer to a clean stream which supports fish life.

The discharge of acid mine wastes in Pennsylvania's streams still furnishes a serious pollution problem, particularly in the bituminous areas. The presence of acid mine drainage in surface streams, very frequently renders such streams unsuitable as sources of public water supply. Fortunately, the topography in many sections of Pennsylvania lends itself to the construction of impounding reservoirs on small surface streams which permit the storage of water in times of plenty for use to meet water demands during prolonged periods of drought.

Ground Water

Last year's drought proved that many of the so-called "unfailing springs" can actually fail, and in those instances where ground water sources must be relied upon, the development of additional underground sources is clearly indicated. We hear persistent rumors that ground water levels throughout the state are decreasing, and that eventually the underground water supply will be exhausted. The United States Geological Survey reports that there is nothing to substantiate such claims, although there are a few localized areas in Pennsylvania where ground water levels have receded to some extent as in the Philadelphia and Pittsburgh areas where pumping is heavy.

Facing a Water Shortage

There are a number of steps a waterworks manager or superintendent can take when faced with a water shortage.

1. The first is *water conservation*. This means restrictions on use.

2. Obtain water from the public water system of a neighboring community.

3. Pump water, after suitable treatment approved by Health Department, from streams, lakes, quar-

DEBIT TO CREDIT—Silt processing plant near Reading, Pa.

The Schuylkill River, restored to a recreational area, once contained 8 ft. of silt

ries or existing wells in or near the community. Many institutions have developed wells which they are willing to connect to the public water system in an emergency.

4. In extreme emergencies, water can be hauled in tank cars or trucks and distributed for drinking purposes.

How To Save Water

The first restrictions usually placed on water consumers consist of bans on lawn sprinkling and car washing. The American Water Works Association, in a recent pamphlet entitled, "Campaigning for Water Conservation," points out that there are two possible approaches to any water conservation campaign — a request for voluntary cooperation, and an enforcement of restrictive legislation, and indicates numerous steps which can be taken by public, commercial, industrial and domestic customers, as follows:

Public Customers

Discontinue street flushing.

Turn off running drinking fountains in parks and other public places.

Cut out the automatic flush feature on toilets in public places.

Limit or eliminate school showers.

Discontinue the washing of public vehicles and transportation facilities.

Discontinue the sprinkling of lawns and gardens in public parks.

Commercial Customers

Commercial customers can cooperate in the following ways:

Serve water only on request in restaurants.

Stop plane washing at airports and train washing at railroad terminals.

Plaster hotel rooms with requests for cooperation by guests.

Delivery trucks and taxicab washing can be stopped.

Dentists can turn off their chair-side taps except when they are actually being used.

Barbers can cease giving hot towels except on request.

Owners and tenants of commercial buildings can institute leak-repair drives.

Reduce to 3 gpm, or even 1½ gpm, the amount of water which can be used in air-conditioning or refrigeration equipment not provided with a recirculation feature.

Ban automobile washing for the duration of the emergency.

Close down skating rinks and swimming pools using public water supply.

Industrial Customers

Each industry offers a separate problem, and can best be attacked on an individual basis.

Domestic Customers

This type of customer can help by taking the following steps:

Repair all plumbing leaks—even a 1/16-inch leak will waste 100 gallons per day.

Replace all faulty washers—even a slow drip will waste 105 gallons per week.

Take showers instead of baths—the usual bath requires 36 gal., the usual shower 25 gal.; 20 gal. is enough for a bath, 1 gal. is enough for a shower if you turn it off while you lather.

Turn the water off while you're shaving—a running tap shave uses about 20 gals., furthermore, it will steam up your mirror.

Reset flushometer toilets to use 3½ instead of the normal 5 to 8 gal.

Reset the toilet tank float to a lower water level.

Don't flush the toilet to dispose of cigarette ashes, soiled tissues, etc.

Stopper your sink or use a dishpan when washing dishes.

Don't leave the water running when you brush your teeth.

Use the basin instead of the shower for your shampoo.

Keep a bottle of drinking water in the refrigerator.

Use only ¼ bottleful to rinse your milk bottles.

Wait until you have a full nine-pound wash before you run your washing machine.

Keep your water heater at an even setting—running water until hot is wasteful.

Think before you turn the tap.

Summary

In all fields of water use, trends toward increases in water demand are evident. The United States Geological Survey has estimated that water requirements in the United States in 1975 will nearly double those of 1950 with an increase of 170 per cent in industrial use, 50 per cent in rural and municipal use, and 25 per cent in irrigation. Pennsylvania's water resources are abundant and should be able to care for future needs, provided they are conserved for use at the proper time and are properly and fairly allocated and distributed. The wise water works administrator must become aware of the general trend towards increased water uses, and make his plans accordingly. The State Health Department will approve auxiliary sources of supply, with appropriate treatment, in real cases of emergency. The best insurance against water shortages is an adequate water supply system. This involves sources, storage, transmission lines, treatment facilities and distribution system.

W&SW

Digester Problems

by JOHN YENCHKO

The digester is only a portion of the sewage treatment plant, but in order to operate it satisfactorily, the operator must understand the function of every unit in his plant, and in particular the grit chamber, the pump station, and the primary tanks.

Temperature

Temperature control is an important item in digester operation. Usually an operator establishes and attempts to keep a uniform temperature within the optimum range of 85° to 95°F. Much more stress has recently been placed on adequate heat exchanging facilities and controls. Flexibility of operation of the digester is important. External heat exchangers, point of discharge, recirculation, supernatant selector, scum breakers and recirculation of digester gas, all contribute to a healthier environment within the digester. The organisms responsible for digestion of sewage solids are appreciably sensitive to temperature variations, which means that a drastic temperature change may result in a troublesome digester.

The pH Value

Operators have learned to rely on their records of pH determination of raw sludge, supernatant liquor and digested solids to ascertain an impending unsatisfactory condition developing in the digester. The optimum pH range is considered to be between 6.8 and 8.2.

Alkalinity

It is generally recognized that acid production occurs when raw sludge is first added to the digester where it undergoes the first stages of digestion. Sufficient alkalinity, serving as a buffer, must be present to counteract this acid trend. The desirable range of alkalinity should be between 2000 to 3500 ppm.

Mr. Yenchko is Asst. Regional Sanitary Engineer, State Dept. of Health, Wilkes-Barre, Pa. His paper was presented at the 26th annual conference of the Penna. Sewage & Industrial Wastes Assn., State College, Pa.

Records

The best criteria the operator has is a record of conditions in his digester when his digester is operating flawlessly; then in the event of an upset, the operator will know in which direction to proceed. These records will show when acid production is out of control, as indicated by the pH or the volatile acid content. Lowered pH and increasing volatile acid concentrations mean impending trouble. An observed deviation from the normal is always a cue to impending difficulties.

Trouble Correction

Acid

Various authorities may disagree about the procedure for correcting an acid condition in a digester, but it is generally recognized that an overloaded condition is a primary cause. Where an operator has facilities he may first reduce the quantity of raw sludge transferred to the upset digester or he can transfer material from the second stage digester to the primary digester. Many of our older plants are not equipped with duplicate digester units nor do they have flexibility for transfer of contents of the digester. The plant at Stroudsburg, Pa. is an example. During the past three years it has been necessary to empty the digester on at least three different occasions. The digester temperature is maintained at 94°F and pH control is effected by means of addition of lime. This permits continuous digestion and yields sludge so well digested that it can be drawn every 5 to 10 days.

Scum

A vexing problem has been the heavy scum accumulation which is also well digested, but because of its consistency cannot be removed by normal means. Flow from the digester to the glass-covered drying beds is by gravity, but only a portion of the contents can be removed. Undoubtedly recirculation or mixing of digester contents might minimize this problem, yet it is my understanding that at other plants with such facilities the supernatent has been adversely affected. Lemoyne, Pa., is experiencing this difficulty with a fixed cover sludge digester.

John Durr of Meadville reported that at New Castle, Pa., C. L. McMillen encountered a scum digester problem, which he solved by the use of a fire department spray nozzle inserted under the roof of the digester through the several test holes.

Foaming

In 1949, the digesters at Radnor-Haverford began to show evidence of foaming. The condition was corrected by raising pH with the application of vacuum filter filtrate. On April 23, 1954, a foaming condition occurred in a primary digester and again the use of the vacuum filter filtrate was successful.

Imhoff Tanks

At Clarks Summit it was found that the solids accumulated at the bottom of the Imhoff tank became so heavy that it was almost impossible to move the slude to the drying beds by virtue of the hydrostatic head available in the tank. This condition results from an excessive amount of grit compacted at the bottom of the Imhoff tank.

The plant in this instance has duplicate Imhoff tanks making it possible to by-pass either of the Imhoff tanks for cleaning purposes. With this arrangement, the operator cleans one of the Imhoff tanks annually.

Emptying either a digester or an Imhoff tank is generally the least desirable type of work attached to the operation of a treatment plant. Where a pump is available the solids must be broken up with a hose, so that they will flow. If the proper help and equipment is provided, the operation can be completed in a matter of two or three days.

At Clarks Summit the men who enter the digestion compartment of the Imhoff tank cannot remain for prolonged periods. The difference between the sludge at Clarks Summit and Stroudsburg must rest with the fact that at Stroudsburg we manage to get rapid digestion of material in the digester. Whereas, in the case of Clarks Summit, the material recently deposited is still in a raw state and naturally is bound to be obnoxious.

Cleaning and Restarting Digesters

We find that a single digester poses the most difficult problem whenever the need arises for emptying the digester. Obviously the plant cannot be bypassed in its entirety and, with the digester out of service, solids will accumulate in the primary tanks and become septic, which will impair the effluent of the secondary treatment units.

It is generally recommended in starting a digester that the contents

of a primary tank be emptied into the digester, a seed be provided if necessary; then await the development of satisfactory digestion conditions and avoid acidification before moving raw sludge to the digester. In the case of a single unit where by-passing is not permissible it is deemed advisable to add lime to the digester to avoid the development of an acid condition.

In the case of Stroudsburg, when the single digester is out of operation, solids are accumulated in the primary and secondary tanks. When the digester is ready to go back into operation this accumulated material is pumped into the digester. The pH is watched very closely and an attempt is made to build up the temperature to the desired 90° to 94°F. Acidity is controlled by adding lime.

Disposal of Sludge

When a digester is to be emptied, disposal of the sludge is sometimes a problem. In the case of Stroudsburg as much as possible of the material was removed to the glass-covered drying beds. The remainder was disposed of by a scavenger. In the case of Clarks Summit, the sludge is pumped to sludge drying bed where facilities are adequate to receive the contents from a single Imhoff tank.

A secondary problem of removing undigested solids from the drying beds sometimes results. To keep down the scum accumulated in the gas vents of the Imhoff tank poses somewhat of a laborious problem. All kinds of gadgets are utilized for this purpose. Bill Warren at Clarks Summit attached an automobile hub cap to a long pole, making an enlarged "plumber helper." Other operators use a spray of utility water.

The "Mechoff"

The operator at Emmetsburg installed a sludge pump with the suction directed to the bottom of the digestion compartment and the discharge to a flexible hose. He found that with this arrangement, which he called "Mechoff," he could recirculate the contents within the digestion compartment thereby breaking up the scum on the gas vents. It is conceivable that a permanent type of installation could be made to recirculate the contents within the digestion compartment of an Imhoff tank to break up the scum accumulated in the gas vents.

In an Imhoff tank, at least a 5 ft. or 6 ft. hydrostatic head is necessary to move the heavy sludge from an Imhoff tank to the sludge drying bed. Generally, the depth of the Imhoff tank below the sludge take-off line may vary from 15 ft. to 20 ft., which means that to dewater the unit, auxiliary equipment must be used. This has a further advantage in that the sludge can be recirculated within the digestion compartment eliminating the need for reversing the flow in a long Imhoff tank.

At the temporary Emmetsburg installation, the operator removed the cap on the extension of the sludge withdrawal line, then inserted the sludge pump suction into the sludge withdrawal line so that he could draw sludge from the bottom of the digester and discharge the material under pressure to the top of the gas vents.

Home Garbage Grinders

Jasper, Indiana is one of the communities to have garbage grinders installed on a community-wide basis. The plant is handling the additional solids loading as well as the additional organic material in solution. The small amount of scum that collects is broken up about once a year with a stream of water when the digester is drawn down. The two-stage digestion affords the operator sufficient flexibility to cope with the problem.

At Erie, Pa., the principle of recirculation and diffusion of digestion gases in a fixed cover digester is used. This produces accelerated digestion at loadings considerably higher than those used for conventional digesters. From visual observation, there was no apparent accumulation of scum on the surface of the digesting sludge.

At Columbus, Ohio, similar results of accelerated digestion are experienced, and satisfactory digestion is completed within five to ten days.

Summary

In summarizing, I would like to state that where we have overloaded digesters in treatment plants, we will continue to have difficulties in the operation of these digesters. In some instances the unsatisfactory condition may result from accumulation of scum. In other cases a toxic substance may be the cause of impeding the digestion process. Overloading or temperature changes may result in acidification and foaming.

When these conditions appear to be non-correctable, as in the case of heavy scum accumulation, the operator seems to have no alternative except to remove the contents of the digester. The most ideal condition would be for the operator to detect this condition before it becomes impossible to handle. This, however, calls for the keeping of continuous and complete records on the operation of the digester.

Seeding, liming, temperature control, and recirculation of digester gases are helpful in the control of digestion. Garbage grinders will contribute additional material to the treatment plant. Municipalities should recognize and provide for such additional solids and organic loads in their treatment plant units. The "Mechoff" would appear to be a tool which could be of considerable value to our Imhoff tank operators.

W&SW

H. K. Gidley Becomes Sec'y-Engr. West Va. Water Commission

Harry K. Gidley, Director, Division of Sanitary Engineering, State Health Department, Charleston, West Virginia, was appointed Executive Secretary-Engineer of the State Water Commission, effective October 1, 1954. In addition to his duties with the Water Commission, Mr. Gidley will continue in his present position as Director of the Division of Sanitary Engineering.

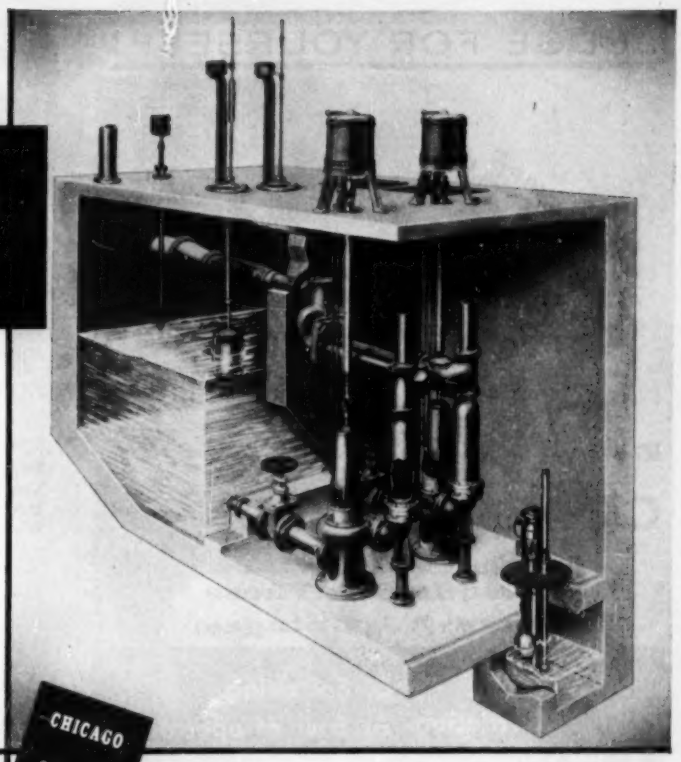
Mr. Gidley has been employed by the State Health Department since 1930 and has served as Director of the Engineering Division since 1949. He is a native of Morgantown and graduated from West Virginia University with a degree in civil engineering. He has done graduate work at the University of North Carolina and has a Master's degree in sanitary engineering from that institution.

Mr. Gidley was recently appointed a member of the Ohio River Valley Water Sanitation Commission. He is a member of the AWWA, West Va. S & IWA, ASCE, APHA, and the West Va. Society of Professional Engineers.

W&SW

OVER 12,000 IN SERVICE

FLUSH-KLEEN
SEWAGE EJECTOR



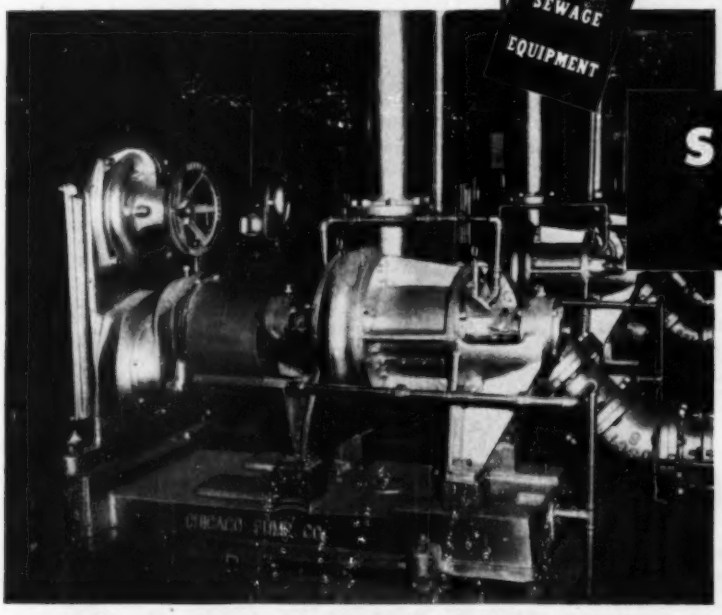
CAN'T CLOG — Only Liquid is Handled by the Impeller

The Flush-Kleen is the *only* truly clog-proof sewage ejector! It strains out coarse matter, then backwashes the strainer for reliable, low maintenance operation. No strainer baskets to clean, no repairs due to clogging, no foul basins because it keeps solids out of the wet basin.

Flush-Kleens last longer and require less power, too, since there are no severe strains, jams or high friction due to handling coarse materials.

Cross section of typical Flush-Kleen lift station. Discharge pipe is cut away to show strainers.

CHICAGO SEWAGE EQUIPMENT



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SCRU-PELLER
SLUDGE PUMP

Scru-Pellers chop all coarse material into small pieces that cannot clog or slow pump. Simple design insures long life and positive pumping. When specified, can be furnished with variable speed drive to permit selection of pump speed and torque that matches consistency of sludge.

Three of 27 Scru-Pellers installed at the Hyperion Plant, Los Angeles, Calif.

Write for Literature and engineering data

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SEWAGE EQUIPMENT DIVISION

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Flush Kleen, Scru-Peller, Plunger Horizontal and Vertical Non-Clog Water Seal Pumping Units, Samplers

Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Comminutors

JUDGE FOR YOURSELF!

IS A Versatile COAGU[LANT]

Because It Has These Superior Advantages:

1. Rapid Floc Formation.
2. PH correction.
3. Taste and odor control.
4. Color removal.
5. Softening.
6. Ease of operation.
7. Bacterial removal.
8. Manganese and Silical removal.
9. Turbidity removal.
10. Economy.

From these advantages you can see why so many users of Ferri-Floc consider it a superior coagulant. Whatever your specific water treatment problem may be, you can figure on Ferri-Floc to do the job adequately and efficiently. A partially hydrated ferric sulphate, Ferri-Floc is a stable, free-flowing, granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy and safe handling as well as storage in closed hoppers over long periods of time.

Water Treatment
Coagulation of surface or well waters. Aids taste and odor control. Effective in lime soda-ash softening. Adaptable to treatment of nearly all industrial water or wastes.

Sewage Treatment
Coagulation of wide PH range. Efficient operation regardless of rapid variations of raw sewage. Effective for conditioning the sludge prior to vacuum filtration or drying on sand beds.

SULPHUR-DIOXIDE SO_2

SULPHUR-DIOXIDE
Is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

COPPER TC SULPHATE

COPPER SULPHATE
Will control about 90% of the microorganisms normally encountered in water treatment plants more economically than any other chemical.

Free Literature!
Samples, Specifications and Detailed Information on Request.

TENNESSEE TC CORPORATION

617-629 Grant Building, Atlanta, Ga.

W & SW

Meetings Scheduled

Dec. 16—Boston Mass. *(Statler Hotel)*
NEW ENGLAND WATER WORKS ASSOCIATION. (Monthly Meeting). Sec'y, Jos C. Knox, 204 Tremont Bldg., Boston, Mass.

Jan. 18, 1955—New York, N. Y. *(Sheraton Hotel)* Grand Ballroom
NEW YORK SECTION A.W.W.A. (Mid-Winter Luncheon Meeting). Sec'y, Kimball Blanchard, 56 Grand Street, White Plains, N. Y.

Jan. 20—Boston, Mass. *(Statler Hotel)*
NEW ENGLAND WATER WORKS ASSOCIATION. Sec'y, Jos C. Knox, 204 Tremont Bldg., Boston, Mass.

Jan. 20-21—New York, N. Y. *(Hotel Belmont Plaza)*
NEW YORK SEWAGE & INDUSTRIAL WASTES ASSOCIATION. Sec'y, R. C. Sweeney, 21 No. Broadway, White Plains, N. Y.

Feb. 9-11—Indianapolis, Ind. *(Lincoln Hotel)*
INDIANA SECTION A.W.W.A. Sec'y, R. J. Becker, 1330 W. Michigan Street, Indianapolis, Ind.

Feb. 17—Boston, Mass. *(Statler Hotel)*
NEW ENGLAND WATER WORKS ASSOCIATION. Sec'y, Jos C. Knox, 204 Tremont Bldg., Boston, Mass.

Mar. 9-12—Boston, Mass. *(Sheraton Plaza Hotel)*
AMERICAN CONCRETE PIPE ASSOCIATION. Director, Howard F. Peckworth, 228 No. LaSalle St., Chicago, Ill.

Mar. 21-23—Savannah, Ga. *(DeSoto Hotel)*
SOUTHEASTERN SECTION A.W.W.A. Sec'y, N. M. de Jarnette, 245 State Office Bldg., Atlanta, Ga.

Apr. 13-15—Hutchinson, Kans. *(Baker Hotel)*
KANSAS SECTION A.W.W.A. Sec'y, H. W. Badley, 119 West Cloud, Salina, Kans.

Apr. 13-15—Lincoln, Neb. *(Cornhusker Hotel)*
NEBRASKA SECTION A.W.W.A. Sec'y, E. Bruce Meier, Univ. of Nebraska, Lincoln, Neb.

Save up to 60% of floor space

with

JOHNSTON Vertical Turbine PUMPS

and reduce maintenance and operating costs!

Here is why rugged, economical Johnston Vertical Turbine Pumps are used for municipal water supply by the City of South Gate, California and are preferred by experienced municipal engineers everywhere. Vertical design saves up to 60% of floor space. They fit in tight places where space is at a premium. No need for costly priming devices—Johnston Pumps can be installed to start and stop easily and require no priming. Low maintenance and operating costs—measured dollar for dollar per year of service, make Johnston Pumps the most economical you can buy. The Johnston dealer in your area will gladly confer with you on your pumping problems. Write for details.

JOHNSTON VERTICAL PUMPS

☐ Kindly send colorful, illustrated bulletin ☐ Have representative call

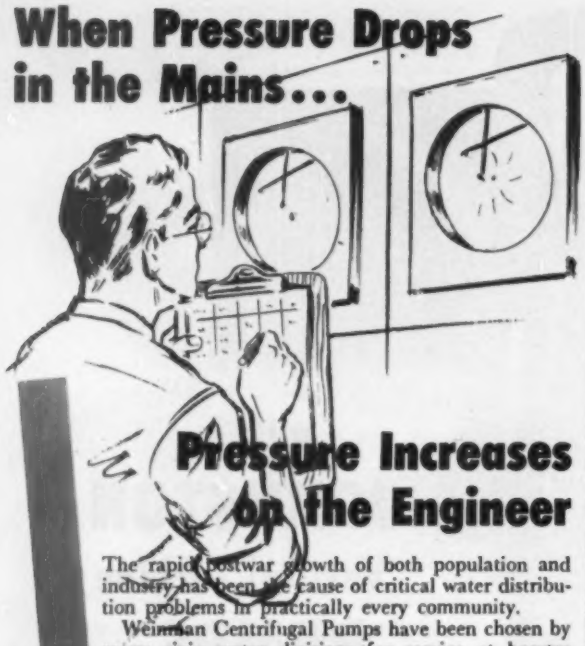
JOHNSTON PUMP COMPANY
Founded in 1909
Bin "K", Pasadena 15, California

Name_____

Address_____

City_____ State_____

When Pressure Drops in the Mains...



Pressure Increases on the Engineer

The rapid postwar growth of both population and industry has been the cause of critical water distribution problems in practically every community.

Weinman Centrifugal Pumps have been chosen by many civic water divisions for service at booster station points in their distribution systems, to provide efficient, dependable pumping under widely varying heads and discharge requirements. Developed by experienced pump engineers, Weinman Pumps are available for high, medium and low head requirements, with single or dual-drive; and for extremely high head conditions, mounted in series to deliver the equivalent of two-stage equipment.

Five 8-inch Horizontal Split Case Weinman Type L2 Double Suction Centrifugal Pumps help provide needed pressure in the new Fisher Road Booster Station of the Columbus, Ohio, Division of Water.

Your community can benefit from dependable Weinman Pump performance. Modern hydraulic and mechanical design, plus precision manufacture from quality materials, make them the best, as well as the most economical buy in centrifugal pumps for any purpose. Write, wire or phone for complete information and illustrated brochure covering Weinman Pumps for your particular requirements.

Representatives in principal cities

WEINMAN

Apr. 14-16—Chandler, Ariz. *(San Marcos Hotel)*
ARIZONA SECTION A.W.W.A. Sec'y, Q. M. Mees, Univ. of Arizona, 721 N. Olsen Ave., Tucson, Ariz.

Apr. 18-20—Quebec, Can. *(Chateau Frontinac)*
CANADIAN SECTION A.W.W.A. Sec'y, Dr. A. E. Berry, Dept. of Health, Parliament Buildings, Toronto, Ont., Can.

Apr. 20-22—Buffalo, N. Y. *(Statler Hotel)*
NEW YORK SECTION A.W.W.A. Sec'y, Kimball Blanchard, 56 Grand Street, White Plains, N. Y.

Apr. 27-30—Riverside, Calif. *(Mission Inn)*
CALIFORNIA SEWAGE & INDUSTRIAL WASTES ASSOCIATION. Sec'y, J. C. Mallery, 4822 Dunsmore Ave., LaCrescenta, Calif.

Apr. 29-30—Butte, Mont. *(Finlen Hotel)*
MONTANA SECTION A.W.W.A. Sec'y, A. W. Clarkson, State Dept. of Health, Helena, Mont.

May 4-6—Pittsburgh, Pa. *(Hotel Webster Hall)*
PENNSYLVANIA SECTION A.W.W.A. Sec'y, L. S. Morgan, State Dept. of Health, Greensburg, Pa.

May 19-21—Chenook, Wash. *(Yakima Hotel)*
PACIFIC NORTHWEST SECTION A.W.W.A. Sec'y, F. D. Jones, Room 305, City Hall, Spokane, Wash.

June 12-17—Chicago, Ill.
AMERICAN WATER WORKS ASSOCIATION. (75th Annual Convention). Exec.-Sec'y, Harry E. Jordan, 521 Fifth Avenue, New York 17, N. Y. (Reservations announcement by Nov. 1st.)

A TIP TO TRAVELERS TO NEW YORK

Hotel Breslin

Moderate rates as low as $3.50 promise you . . .

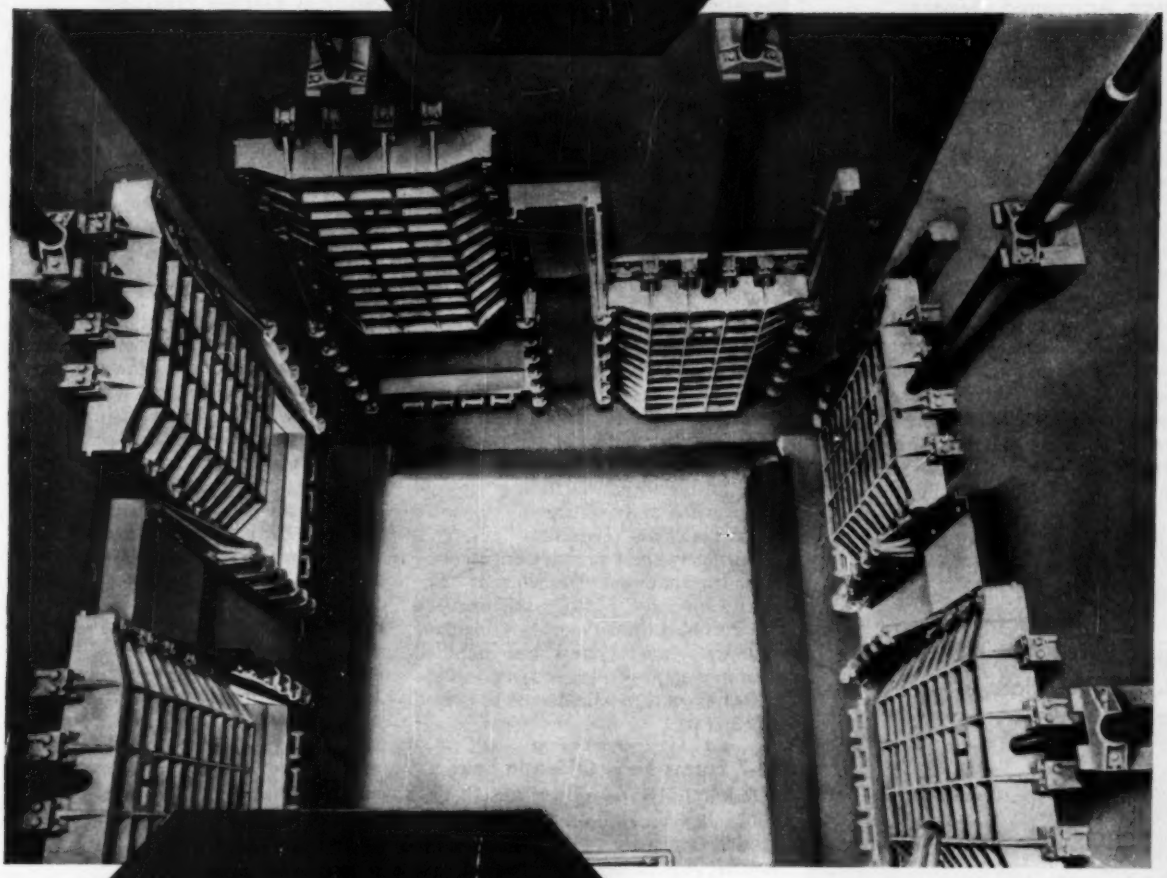
- modern, restful rooms with private bath
- delightful dining room
- Cocktail Lounge
- Garage
- the thrill and excitement of all

New York

One block off Fifth Avenue, Broadway at 29th Street

Write to Hotel Breslin for FREE New York City Map

When you must be SURE...



For Instance . . .

Think how important it was on this huge project to be sure of proved design, dependable operation and long life, *always* engineered into Rodney Hunt equipment. In addition to units shown, other Rodney Hunt sluice gates as big as 8′ x 8′ clear opening were installed in this underground reservoir and filter plant built for one of our greatest cities.

When you must be SURE

you CAN be sure with Rodney Hunt water control apparatus.

More than 2000 combinations of Sluice Gates and Hoists are described in our 232-page profusely illustrated catalog with valuable 28-page section on engineering data. Write *today* on your letterhead for Catalog WCA 952.

Manufacturing Engineers Since 1840

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Rodney Hunt agents in principal cities throughout the United States

W&SW

Manufacturers' News

Krapf Appointed General Manager of Bulkley Dunton

Bulkley, Dunton Processes, Inc., New York, N. Y., has announced the appointment of William L. Krapf to the post of General Manager of the Company. For the past three years Mr. Krapf was assistant to the Executive Vice President of the firm.

Prior to joining Bulkley, Dunton, Krapf was a Sales Engineer for United Board and Carton Co., and Bulkley, Dunton Pulp Co.

Link-Belt Opens New Ware-House in Portland

Link-Belt Co., Chicago, Ill., has announced that a modern district sales office and warehouse built by the Company in the Guilds Lake area of Portland, Oregon, was officially opened the last of October with an open house attended by about 400 people.

"The expansion in Portland is a reflection of the company's effort to give the best possible service to industry in the Pacific Northwest," commented Lester T. Graham, Link-Belt district manager in Portland.

The new company-owned building, at 3030 N. W. Industrial Street, includes office space, large warehouse facilities and a factory branch store. It has been designed so that it can be easily expanded in the future.

Besselievre Heads New Industrial Wastes Div. Of Kaighin & Hughes

Kaighin & Hughes, Inc., Toledo, Ohio, has announced the formation of an Industrial Wastes Division headed by Edmund B. Besselievre.

With organization of the new division, the company is equipped to provide all services, including design, engineering and contracting to solve waste materials problems.

Formerly chief sanitary engineer of The International Division of The Dorr Company, Mr. Besselievre is a recognized authority on treatment of industrial wastes and has handled sanitary engineering projects in 63 countries of the world over a period of 30 years.

B-I-F Forms New Office in Texas

B-I-F Industries, Inc., Providence, R. I., has announced the formation of a new Texas division with sales and service offices in Houston and Dallas, Texas. It is known as B-I-F Texas, Inc., Southwest Division of B-I-F Industries, Inc. The move was made to provide increased accommodation and service to customers in the Southwest area. B-I-F Texas, Inc., represents Builders-Providence, Inc., Omega Machine Co., and Proportioneers, Inc. The main office in Houston is staffed by John B. Mackenzie, Jr., a vice president of B-I-F Texas, Inc., Charles J. Wolfer, Raymond W. McIndoe, Jr., and Mrs. Lollie R. Lowe. The Dallas office includes Edward Morey, Jr., also a vice president of B-I-F Texas, Inc., Lewis H. Johnson, Jr., Mrs. Floy Brazell, all former members of the firm, Morey and Morey, who for some 33 years represented B-I-F Industries, Inc., in the Southwest, Richard L. Lauderdale and Clem D. Hoye, Jr., who is the factory-trained serviceman for B-I-F Texas, Inc.

Drastrup Elected President Of A. M. Byers

A. M. Byers Co., Pittsburgh, Pa., has announced that A. B. Drastrup was elected president of the company. He succeeds L. F. Rains, who retired in October after 23 years as president and a director of the company.

Mr. Drastrup, 50, has been executive vice president of Byers since February, 1954. He joined the company in 1931 as plant auditor and also served as special assistant to the vice president in charge of operations during the war years. He became manager of steel sales in 1946 and assistant to the president in 1951.

Johnston Pump Appoints Schleeweis

Johnston Pump Company, Pasadena, Calif., has announced the appointment of Charles J. Schleeweis as sales manager. Mr. Schleeweis comes to his new post with a long background of experience with Johnston Pump Company which he joined in 1946. For the past six years he has been manager of the firm's export sales and has travelled extensively throughout Latin America, India, the Middle East and other parts of the world where Johnston Pumps are serving industry, governments and agriculture.

Mr. Schleeweis will have charge of the supervision of all domestic and foreign sales for the diversified line of Johnston vertical turbine pumps.

Jeffrey Promotes District Office Personnel

The Jeffrey Manufacturing Company, Columbus, Ohio, has announced several promotions in district office personnel.

Walter J. Hulsey, a sales engineer with the Birmingham District Office, has been named district manager, Conveyor Division, there. Joining him as sales engineer in that office is J. Thomas Berg from the home office.

Howard S. Davies, former Conveyor Division district manager in the Chicago District Office, has been moved to a similar post in the Pittsburgh District Office. Replacing him in Chicago is James B. Green, for a number of years assistant to the chief engineer at the Jeffrey home office.

Being transferred from Pittsburgh are E. E. Balduff and Travers W. Nelson, both sales engineers. The former has gone to Orlando, Florida, to work in the Jacksonville District Office territory. The latter has become manager of the District Office in Jacksonville.

William A. Cheney has been transferred from the Merchandise Sales Department in Columbus to the post of Sales engineer in the New York District Office. Vernon L. Ekblad, former sales engineer in the General Engineering Sales Division at Columbus, has taken a similar position in the Houston District Office. Robert F. Farrell has become a sales engineer in the Columbus District Office, replacing Robert D. Henning who has moved from that post to a similar post in the home office Products Engineering Sales Division. Robert M. Dunn has become associated with the Knoxville District Office in a sales engineer capacity. George S. Kepley has been transferred from Coal Preparation Engineering Sales in the home office to the Pittsburgh District Office, as has been Edward G. Braun, former sales engineer with the Buffalo District Office.

Cast Iron Pressure Pipe Institute Moves Offices

The Cast Iron Pressure Pipe Institute, Washington, D. C., has announced that Mr. Sidney E. Linderman, Executive Vice Chairman of the Institute is now located at the new offices in the Pennsylvania Building, 425 13th Street, N.W., Washington 4, D. C.

Builders-Pacific, Inc. Changes Its Name

B-I-F Industries, Inc., Providence, R. I., has announced that its West Coast affiliate, Builders-Pacific, Inc., has changed its name to B-I-F Pacific, Inc., West Coast Division of B-I-F Industries, Inc., with offices in San Francisco and Los Angeles, California, and Phoenix, Arizona. The change was made to more closely identify this division with its parent company. It continues as the sales and service representative of Builders-Providence, Inc., Omega Machine Co., and Proportioneers, Inc., in northern California and Arizona, and as representatives of Builders-Providence, Inc., and Omega Machine Co. in southern California.

Leon Hoyt Chamberlain is President and Sales Manager of B-I-F Pacific, Inc. Mr. Chamberlain, with an extensive background in the water and sewage works field, joined B-I-F Industries, Inc., in 1946. He is a member of the American Society of Mechanical Engineers, American Water Works Association, Federation of Sewage & Industrial Waste Association, and Instrument Society of America.

S. Morgan Smith Expands Atlanta Office

The S. Morgan Smith Company, York, Pennsylvania, has announced that a representative of its Turbine Sales Division has been added to the Company district office located at 3240 Peachtree Road N. E., Atlanta 5, Georgia.

The new District Manager of Turbine Sales will be Robert A. Cyphers, formerly of the York offices. Southern District Manager of Valve Sales for the Company, located in the same office, is Curtis A. Lau. A full line of S. Morgan Smith Company hydraulic power equipment is now offered through the Atlanta office.

Hamer Appoints New Representative

The Shelby Jones Co., Havertown, Penna., has been appointed as exclusive Sales Representative for Hamer Valves in the Eastern Pennsylvania, Delaware and Southern New Jersey territories.

Shelby Jones, head of his company, has spent the last twenty-five years in the industrial supply field, and has his company headquarters in Havertown, which is just outside of Philadelphia.

Le Roi Names Heuser Sales Vice President

Le Roi Company, Milwaukee, Wis., has announced the appointment of Jack E. Heuser, to Vice President in charge of sales.

Hauser will be responsible for the organization and management of a newly created Sales Division which will sell and service all Le Roi products.

An engineering graduate of the University of Wisconsin, Heuser joined Le Roi in 1939. In 1941 he became a member of the Ampco Metal sales organization and served as manager of their Pittsburgh district and later the Los Angeles district. In 1946 he rejoined Le Roi as Assistant to the General Sales Manager. In accepting a vice presidency, Heuser vacates the post of Engine Division Sales Manager.

Hooker Promotes Miller

Hooker Electrochemical Company, Niagara Falls, N. Y., has announced that Harris C. Miller has been promoted to New York district sales manager. Mr. Miller was formerly assistant New York district sales manager. He replaces William F. George who has retired in line with the company's retirement policy.

A native of Boston, Mass,, Mr. Miller graduated from North Quincy High School. He spent two years at St. Lawrence University and one year at Massachusetts Institute of Technology. He then spent two years at Worcester Polytechnic Institute from which he was graduated in 1941 with the degree of bachelor of science in chemical engineering. He then came directly to Hooker Electrochemical at Niagara Falls where he was chemical engineer in the operations department until 1949, when he was transferred to the sales department. He shortly became a salesman in the New York district with headquarters at the company's offices in the Lincoln Building, New York City.

During 1951 and 1952 his sales territory was Western New York and Western Pennsylvania with his headquarters at Niagara Falls. He was then again transferred to the New York district.

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

W&SW

New Equipment

New Service Saddle

1201

Dresser Manufacturing Division, Bradford, Pa., has announced the new Dresser Service Saddle (Style 91). A complete line in size 2" ID through 12" are being supplied for tapping asbestos-cement, cast iron and steel pipe.

The saddles are available heavily galvanized or with an economical special plastic dip. The plastic is non-toxic, does not "plate out" and has dielectric strength.

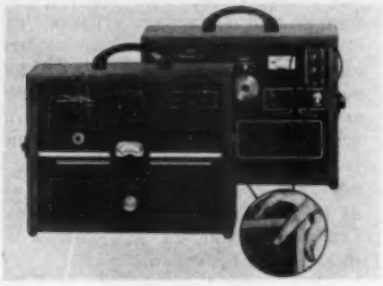
Other features of the Dresser Service Saddle include the flat straps with rolled threads. The flat straps give greater bearing surface on the pipe to prevent cutting or crushing. Rolled threads provide greater strength since no metal is cut away. Special Dresser rubber compound gaskets are cemented in place.

Dresser Saddles have a wide range of fit which permits use interchangeably on asbestos-cement pipe and cast iron pipe in leading sizes. They are supplied with either corporation stop thread or IPS thread taps up to 2" in size. All Dresser Service Saddles are packaged for convenience in storage, inventory and use.

Instantaneous Battery Testing For Detectron Pipe Detector

1202

The Detectron Corp., No. Hollywood, Calif., has developed a battery



test switch for the instantaneous testing of both transmitter and receiver batteries for the model "505" Pipe Detector.

This new feature makes it possible for the operator to have positive assurance of maximum battery function at all times. Present owners of older model "505" Pipe Detectors can have the new test-switch feature readily installed in their present model at nominal cost.

Among other new design features, the Detectron "505" offers the latest electronic tubes, a specially constructed vibration pickup for maximum sensitivity, an aluminum case the use of standard batteries.

New River-Crossing Pipe

1203

James B. Clow & Sons, Chicago, Illinois, has developed a new river-crossing that may be deflected as much as 15° without impeding the flow of the pipe's contents. The reason for this free-flowing characteristic, even with extreme deflection, lies in the new ball-and-socket design of the pipe.

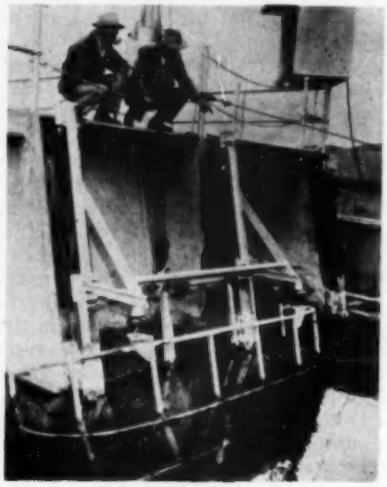
Other advantages claimed for this pipe are: only 3 pieces to each joint (1 complete pipe, 1 solid follower ring, 1 solid ring gasket), besides the bolts and nuts; no split parts; rubber gasket symmetrical in cross section, and cannot be installed the wrong way. Lower labor installation costs result from the greater ease of joint make-up, Clow asserts, and from the longer laying lengths (approximately 18'6" long).

Electric Fish Screen

1204

In response to several inquiries from our readers we are repeating this item on Electric Fish Screens that we ran as New Equipment several years ago.

The Electric Fish Screen Co., Hollywood, Calif., has available the Burkey Electric Fish Screen that is designed to control the movement of fish (and other types of marine life, such as shrimp, crabs, eels, etc.). It does not impede the flow of water, nor does it harm the fish, as is often the case with mechanical screens.



The electric screen consists of three simple parts: (1) A Westinghouse Electronic Pulse Generator—employing industrial-type vacuum tubes, and operating without moving parts—housed in one weatherproof cabinet; (2) The "live" electrodes, suspended to swing freely from an overhead support, yet clearing the bottom of the stream, or intake, permitting the passage of debris; and (3) The "ground," or second electrode system provided to complete the circuit through the water, thereby creating the "electrified zone of water," which is actually the "Electric Fish Screen."

Meter Swipe Solves Condensation Problems

1205

The Mitchell Meter Swipe Sales Co., Seattle, Washington, has available the Mitchell Meter Swipe that is said to be the practical solution of fog and condensation problems in meters.

(Continued on page 100A)

Lake Fort Smith, the Clear Creek Water System's storage reservoir. Filter House is in lower left foreground.

ALOXITE® underdrains used for Fort Smith's Clear Creek Water System

The Clear Creek Water System, which supplies 75,000 people in and around Fort Smith, Arkansas, ranks among the most modern in the Southwest. Soft, sparkling clear Ozark Mountain water is piped from Lake Fort Smith to the City's distribution system through 23 miles of conduit. Put into service in 1936, the system has been expanded twice. The first addition was made in 1942; the second one has just been completed.

The filter plant, located just south of Lake Fort Smith's effluent, has a rated capacity of 12MGD. According to Jay Medlen, Fort Smith Public Works Commissioner, the ALOXITE® aluminum oxide porous underdrains used throughout the plant have proved most successful, providing trouble-free, economical service. Backwash is complete, without mud balls. Loss of head is held to a minimum. And since there is no need for graded gravel support, the problem of upset beds is eliminated.

Fort Smith deserves congratulations for its modern, efficient water system. Credit also must go to W. R. Holway and Associates, Designing Engineers, of Tulsa, Oklahoma, who designed and built the original plant and the latest additions; and to the S. E. Evans Construction Company, of Fort Smith, Arkansas, as principal contractor for the furnishing and placing of 70,000 feet of 36 inch prestressed reinforced concrete pipe, including a 3,000 foot tunnel under the Arkansas River at Van Buren, Arkansas; and to Foresgren Brothers, of Fort Smith, Arkansas, as principal contractors on additional clear wells and filter plant expansion.

Write us for this informative 56-page booklet on porous media for all fields of filtration and diffusion. It's yours for the asking.

CARBORUNDUM

Registered Trade Mark

Dept. M-124, Refractories Div. Perth Amboy, New Jersey

The meter swipe fits all meters and requires no changes in the case or cover, and is easily installed by simply changing the glass. The adjustable swipe pad can be set to strike over the various positions of the reading registers, and will clear any 3 dials of the circular reading meter. The swipe is said to save as much as 1 to 2 hours reading time daily and cuts down on rechecks.

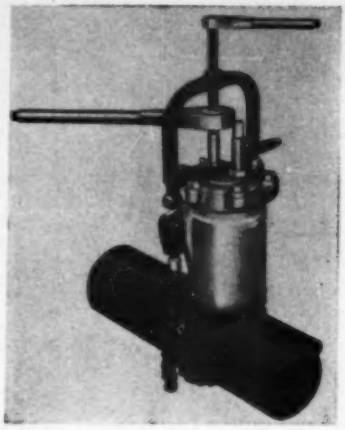
Aluminum Tapping Machine

1206

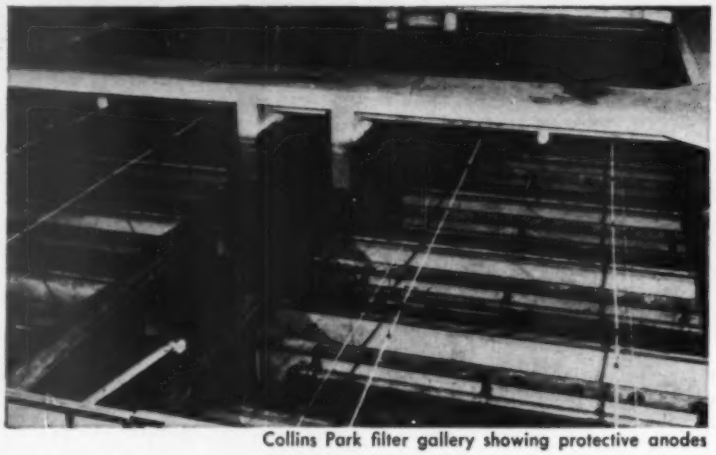
Hays Manufacturing Company, Erie, Pa., has produced a tapping machine for which it claims several distinctive advantages. The new HAYS Model "B" is now made of high strength aluminum alloy, reducing the weight and making it much easier to carry and operate. There are only 36 pounds to handle, and the manufacturer states that it requires a minimum working space.

The HAYS Model "B" is designed to drill, tap, and install the corporation stop without disassembling the machine and the complete operation is performed under full pressure.

The machine handles all standard makes of corporation stops, from ½" through 1". Complete accessories include saddles, chain, wrenches, etc. A renewable bearing bronze feed yoke insert adds to maintenance economy.



CONTROLLING CORROSION.....



Collins Park filter gallery showing protective anodes

TOLEDO WATER SUPPLY GUARDED BY CATHODIC PROTECTION

Effectiveness of E.R.P. system proved conclusively by over 2 years of comparative tests

Assuring an uninterrupted supply of water to a metropolitan area of 385,000 people requires dependable corrosion control of tons of buried and submerged steel. At Toledo, Ohio, cathodic protection systems engineered specifically to fit the needs of each job guard against the corrosion failure of a one-million gallon wash water tank, the surface wash pipes in 20 double filter basins, and a mile-long, 16-inch water main.

These are typical applications of cathodic protection "know-how" by our Engineering Division that *since 1935* has been successfully controlling corrosion of buried and submerged steel structures of all types. Toledo's experience may help solve *your* corrosion problem too—write us for your copy of Toledo's own story of corrosion prevention.

ELECTRO RUST-PROOFING CORP. (N. J.)

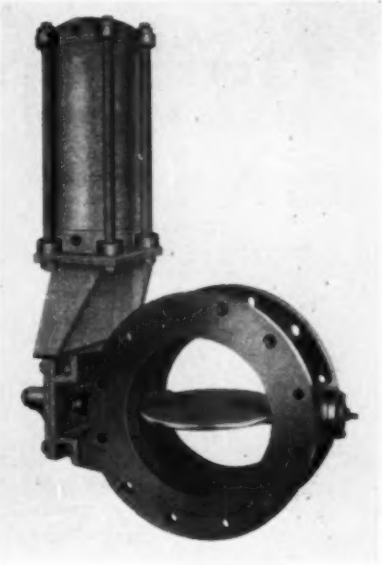
30 MAIN STREET, BELLEVILLE 9, N. J.

E-29

Butterfly Valves

1207

Builders-Providence, Inc., Providence, R. I., has announced that it is extending its line of Butterfly Valves to include Rubber-seated, Tight-closing Butterfly Valves for general service. Utilitarian design and rugged construction are combined for positive, trouble-free performance in these valves which meet the American Water Works Association's Tentative Standard Specifications for Rubber-Seated Butterfly Valves, AWWA C504-54T. Accessories include manual, electric, hydraulic and pneumatic operators.



(Continued on page 102A)

ELIMINATES

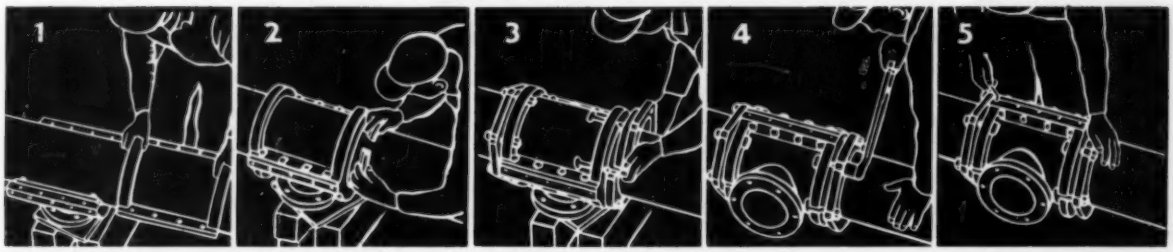
MELTING

POURING

CAULKING

SMITH TAPPING SLEEVE & VALVE

NOTE THE SIMPLE INSTALLATION PROCEDURE



Smith Mechanical Joint Tapping Sleeves are installed as follows: 1. Block Sleeve outlet half under pipe, position side flange gaskets. 2. Bolt Sleeve halves together, position end joint gaskets. 3. Install follower rings, hand tighten bolts and nuts. 4. Rotate Sleeve outlet flange to desired position, tighten follower ring nuts. 5. Tighten side flange gasket compression screws, attach Tapping Valve. The permanent leakproof installation is complete and ready for tapping. The installed cost of Tapping Sleeve and Valve connections is reduced by quicker assembly, elimination of skilled labor and costly jointing material. Bulletin MJ1 will be immediately sent on request.

50

FIRE HYDRANTS · VALVES · SINCE 1896

THE A.P. SMITH MFG. CO.

EAST ORANGE, NEW JERSEY

Ferguson Pipe And Cable Layer

An Intriguing Machine

1208

Specially designed to install flexible pipe and cable underground at low cost, the new Ferguson Pipe and Cable Layer eliminates laborious hand digging or expensive machine trenching. This new tractor tool retails at well under a hundred dollars, quickly attaches to the Ferguson Tractor, and will put flexible piping up to 1½" in diameter into the ground up to 18" deep in a matter of minutes. It is believed this practical, low-cost tool will find many applications wherever relatively shallow underground flexible pipe or cable installations are desirable and practical.

Actually the Pipe and Cable Layer is an agricultural "subsoiler" to which is added a guide tube for conducting pipe or cable into the bottom of the cut; guide rings are mounted on the tractor for conducting the pipe or cable back to the guide tube. The entire unit can be mounted on the tractor and readied for action in a few minutes.

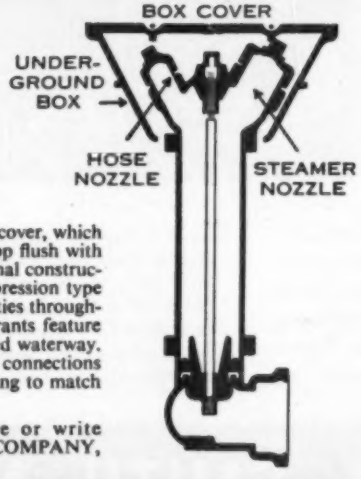
(By removing the guide tube, the unit can be operated as a subsoiler to increase moisture penetration and conservation—or to improve drainage. Maximum penetration is about 22 inches.)

To lay flexible pipe or cable, an exploratory subsoiling pass is first made with the tractor and subsoiler over the route of the projected line, so that any rocks, roots or other underground obstructions present may be cleared away. Then the length of pipe or cable to be installed is laid out right alongside the cut.

At the beginning of the route, the pipe or cable is then threaded through the front guide ring on the tractor, rear guide ring and guide tube attached to the subsoiler beam. When the tractor is driven forward, the subsoiling beam goes deep into the ground and the piping or cable slips through the guides, automatically being deposited at the bottom of the subsoil cut. Speeds of as high as 300 feet per minute are practical.

After the piping or cable is laid, the resulting slight ridge in the ground is leveled by merely driving over it with the rear tractor wheel.

Features of the new Ferguson Pipe and Cable Layer are: (1) Handles flexible pipe ½" to 1½" in diameter, and heavy-duty electrical cable. (2) Installs pipe or cable up to 18" deep. (3) Adjustable roller bracket on base keeps pipe or cable on bottom of slit for maximum depth. (4) Leaves the ground level. No trenching or backfilling is involved in the entire operation.



This M & H Hydrant sets completely underground. The cast iron box cover is on line with the ground level, thus completely eliminating any interference with traffic. M & H flush type hydrants are especially designed for use at airports servicing the heaviest modern airplanes.

The operating nut and nozzles are accessible simply by lifting the two piece cover, which has disappearing handles designed to drop flush with the cover when not in use. Hydrant internal construction is exactly the same as M & H compression type fire hydrants used by so many municipalities throughout the country. M & H flush type hydrants feature a 5¼" valve opening and an unobstructed waterway. Can be supplied with one or two fire hose connections and/or with steamer nozzle, with threading to match existing standards.

For additional information, wire or write M & H VALVE AND FITTINGS COMPANY, ANNISTON, ALABAMA.

M&H PRODUCT

FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION

Root Remover For Pipe Lines

1209

Reliance Chemicals Corp, Houston, Texas, has available Rootox for simple and economical root control in sewer lines.

Rootox is described as a compounded bolet whose toxic ingredient is copper sulfate, manufactured to obtain a controlled solution rate from 1 to 4 hours, depending on sewage

THEY DON'T BURN MONEY IN SCHENECTADY

Designed by Havens & Emerson, New York, N. Y.
Constructed by McElwee-Courbis, Camden, N. J.

C-E RAYMOND FLASH DRYING SYSTEMS PRODUCING FERTILIZER

CITY	TREATMENT	NO. UNITS	SIZE OF UNITS Lb. Water per Hour per Unit	INSTALLED CAPACITY Tons Fertilizer Per Year
Baltimore, Maryland	Act. Dig.	3	6,140	29,800
Battle Creek, Michigan	Pri. Dig.	1	2,370	2,550
Chicago, Illinois				
Calumet	Activated	3	6,667	15,850
Southwest	Activated	8	21,000	148,500
Southwest Ext.	Activated	6	21,000	49,500
Edgewater, New Jersey	Pri. Dig.	1	795	150
Fond Du Lac, Wisconsin	Pri. Dig.	1	2,350	1,300
Houston, Texas	Activated	2	12,000	30,400
Lansing, Michigan	Act. Dig. & Garbage	1	6,667	6,780
Los Angeles, California	Act. Dig.	4	22,500	79,500
Recife, Brazil	Pri. Dig.	1	943	1,280
San Diego, California				
#1 Plant	Pri. Dig.	1	3,500	7,500
#2 Plant	Pri. Dig.	1	5,000	13,200
San Francisco, California	Pri. Dig.	3	6,250	36,400
Schenectady, N. Y.	Pri. Dig.	1	3,370	2,970
Sheboygan, Wisconsin	Pri. Dig.	1	3,040	3,060
Stamford, Connecticut	Pri. Dig.	1	3,330	1,780
Washington, D. C.	Pri. Dig. now Act. Dig. later	3	12,000	65,500
Wyomissing, Pennsylvania	Pri. Dig.	1	2,218	848

COMBUSTION ENGINEERING
RAYMOND DIVISION
1315 North Branch Street, Chicago 22, Illinois

Instead, the new sewage d'sposal plant at Schenectady, New York, *saves* money – sizable sums accruing from the sale of Orgro – Schenectady's effective soil conditioner and fertilizer composed entirely of flash-dried sewage sludge.

As in many other communities, a C-E Flash Drying System has converted what would otherwise be a bothersome liability into a revenue-producing asset. By drying, packaging and selling its sludge, and then deducting all fuel, power, labor and bagging costs from the revenue received, Schenectady nets approximately $15.00 for each ton of dry solids sold. Thus far the demand for Orgro has been so great that an average week's production is sold at the plant in a matter of hours. During the winter months, when consumer demand may drop off, Orgro will be bagged, stored and kept ready for use the following spring, on the city's parks and golf courses.

Had Schenectady elected to incinerate its sludge, not alone would all revenue be eliminated, but in addition, a cost of about $3.00 per ton would be incurred for ash disposal – a substantial item, since roughly 50% of the original dry weight of incinerated sludge remains as ash.

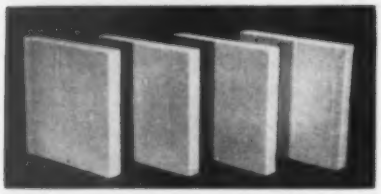
In communities where the character of the sludge makes it unsuitable for use as fertilizer, incineration may be the only answer. But in the many instances where these limitations do not apply, burning sludge may be equivalent to burning money.

Whether you plan to incinerate or dry, the C-E Raymond Flash Drying System allows you to do either at will. Like the communities listed at the left, you too can end your sludge disposal problems effectively and at less cost with the service-proved C-E Raymond System. For full information, contact the C-E Raymond office nearest you. A C-E specialist will be glad to help you. B-792

Eastern Office: 200 Madison Avenue, New York 16, New York • Western Office: 510 West Sixth Street, Los Angeles 14, California

ALSO FLASH DRYING AND INCINERATION SYSTEMS FOR INDUSTRIAL WASTE DISPOSAL

FILTROS brings Substantial SAVINGS and Increased EFFICIENCY to Water Filtration



Modern porous plate underdrain systems of FILTROS silica offer new efficiency in water filtration—PLUS installation and maintenance savings. Consider these advantages:

1. No graded gravel needed.
2. Complete back washing.
3. Prevents formation of mud balls.
4. Porous plates resist corrosion.
5. Round grain construction gives better filtration rate.
6. No metal parts to corrode.
7. Built for maximum efficiency and economy.
8. Maintenance easy; required less frequently.
9. Last indefinitely.

We will gladly show you how FILTROS can modernize and simplify your filtration system at moderate cost. Write today for complete information.

FILTROS Porous Plates and Tubes for Air Diffusion in Sewage Treatment Plants also have outstanding advantages. Ask for information.

FILTROS INC.

602 W. Commercial St., East Rochester, New York

Pioneer Manufacturers of Porous Ceramics Since 1913

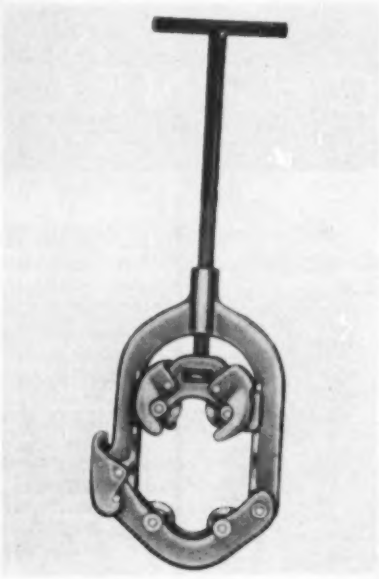
composition, temperature, and rate of flow. The built-in solution rate of Rootox provides a steady leaching of small quantities of copper which paralyzes the drinking mechanism of the root tips thus resulting in local killing action. Rootox will dissolve readily in the presence of little or no flow and is shaped to stay in the line for a long time for maximum results.

Hinged Cutter

1210

The Reed Manufacturing Company, Erie, Pa., has announced a completely new design in cutters for large size cast iron or steel pipe.

Offered in several sizes to cover the complete range from 2½" to 12", the new Reed cutters feature a hinged yoke construction which calls for the very minimum of digging in ditch work and completely eliminates "spring" from the tool.



The use of four Reed razor blade wheels speeds cutting and further serves to reduce the amount of digging required in ditch work, since the handle swing necessary for complete cutting is only slightly more than 90°. The special design of the Reed wheels rolls down the outside burr on steel pipe and eliminates any need for filing. Wheels for steel or cast iron pipe can be quickly interchanged.

Perfect tracking of the wheels is said to result from the patented, four-point pipe guide which automatically positions the tool for a right-angle cut.

Remember: the VALVES you buy today may have to be maintained by your GRANDCHILDREN!

Specify **IOWA** because...

you can always count on Iowa for a lasting source of replacement parts . . . and products that service easily.

Look for These Features:

Double disc, parallel seat . . . positive wedging action for efficient, no-leak closing . . . gates hung loosely from stem nut—no binding . . . rugged, time-proved design means long life, low service costs . . . available with bell, flange, or mechanical joint connections to fit any existing or planned installation . . meet all A.W.W.A. specifications.

IOWA gate valves . . . for details, phone, wire or write:

IOWA VALVE COMPANY

A subsidiary of James B. Clow & Sons

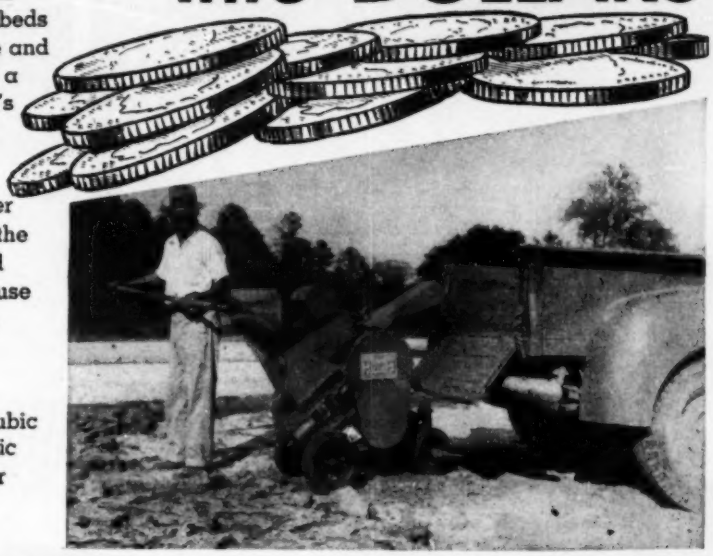
201-299 N. Talman Ave., Chicago 80, Ill.

Process Your Sewage Sludge Into DOLLARS

It's a simple operation with the Royer Sludge Disintegrator. All you need do is feed the sludge direct from the drying beds into the hopper of this efficient machine and "dollars" are discharged in the form of a valuable, readily saleable fertilizer. It's as easy as that. No high installation costs; no skilled labor required.

The "combing belt" action of the Royer completely shreds, mixes and aerates the sludge, discharging a finely pulverized product, free of all trash. The ready-to-use fertilizer so processed is quickly sold to florists and nurserymen, golf clubs, gardeners, parks.

Available in capacities from 1 to 150 cubic yards per hour; gasoline engine, electric motor or belt-to-tractor driven. Send for bulletin giving details.



A Royer processing sludge in a Georgia sewage disposal plant.

ROYER foundry & machine co.

170 PRINGLE ST., KINGSTON, PA.

ROYER

Almost old enough to vote!

Nineteen years old and still going strong! The oldest of all sludge incineration methods—the original Dearborn, Michigan, installation, has provided thousands of hours of faithful, trouble-free, odor-free sludge incineration with Nichols Herreshoff furnaces.

Dozens of municipalities all over the country are finding Nichols Herreshoff Dryer-Incinerators to be a good investment. No other method of sludge incineration provides such rugged equipment, such dependable service, such low cost disposal.

If you want to burn all solids—grit included, with the least trouble . . . consult Nichols.

Nichols Herreshoff
Multiple Hearth Dryer-Incinerators

Nichols Engineering & Research Corp.

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• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

NO GUIDES — for better performance and greater economy

Leonard rakes operate without guides directly on trash rack bars . . . ride down over stubborn obstructions and work them loose. This freedom of movement assures fast, easy cleaning of the rack bars. No channel guides need be attached to bars or embedded in concrete piers. The initial cost is much less because the width of Leonard rakes can be kept to a minimum and the expense of guides eliminated.

Rake teeth parallel rack bars to clear debris and obstacles on descent, tilt to a perpendicular position when ascending and carry all extraneous matter to the unloading position. Operation is by an electric hoist on either inclined or vertical stationary rack bars.

For information on Leonard trash rack rakes and other accessories as well as the design and manufacture of hydraulic turbines, write to S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines · Gates & Hoists · Trash Rakes · Pumps · Accessories

HYDRODYNAMICS

Rotovalves · Free-Discharge Valves · Ball Valves · Butterfly Valves · Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

Loss-In-Weight Recorder For Volumetric Feeder

1211

Omega Machine Co., Providence, R. I., has redesigned and improved its equipment for checking and recording the rate of feed of volumetric feeders by the Loss-In-Weight method. This recorder is now available for small as well as large chemical feeders. Applications include: water treatment (particularly fluoridation), sewage and waste treatment, and any chemical processing operations where records of chemical feeding are desired.

The Loss-In-Weight Recorder is compact and extremely simple, with no motors, switches, relays, clutches or electrical parts (except for simple chart movement) to require maintenance. When attached to a volumetric feeder, it does not increase the space requirements of the standard feeder. An indicator scale continuously shows the weight of chemicals left in the hopper and indicates when hopper refilling is necessary. Standard 24-hour recorder charts in 50 or 100 lb. capacity (for the Omega Model 50 Disc Feeder) records the time of hopper reloading and gives a continuous and exact record of feeding operations.

Portable Power Saw Features Reciprocating Blade

1212

Wright Power Saw and Tool Corp., Stratford, Conn., has developed the

"WE LIKE THEM FINE"
WRITES PAINESVILLE, OHIO OF ITS "Flexibles"

You'll notice these members of the Painesville Sewer Service Division are smiling. And no wonder. They've had their Flexible SeweRodeR three years . . . the power bucket machines two years. They know how much hard, hot dirty work "Flexibles" eliminate. How fast the equipment works in emergencies . . . how efficient it is for preventative maintenance.

A special advantage of the SeweRodeR is its compactness, requiring only 18 feet of overall working space. It's easy to operate in congested areas, alleyways, etc., without tying up traffic. It rods up to 3,000 feet per day at a cost of less than 3¢ per foot, with no exposed rods on the street.

Seen in the group picture, left to right, are Stephen L. Lyon, Sewer Service Division, Larry Hanifon, Assistant Foreman, Churchill (Shorty) Brewster, Operator, and Gilbert (Jack) Miller, Operator.

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(DISTRIBUTORS IN PRINCIPAL CITIES)

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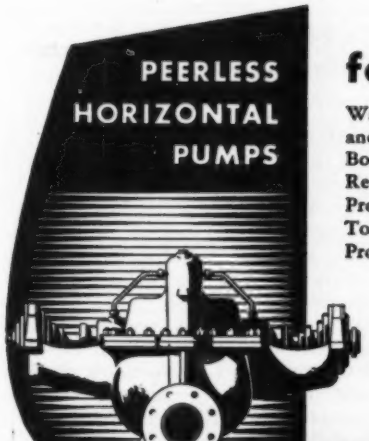
PEERLESS HORIZONTAL PUMPS



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Write for descriptive Bulletin on type you require.

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PEERLESS BUILDS DEPENDABLE PUMPS

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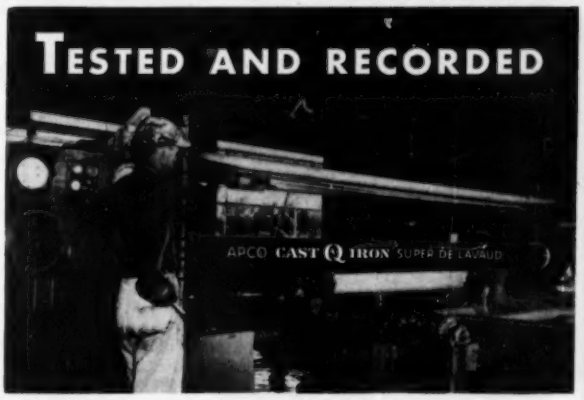

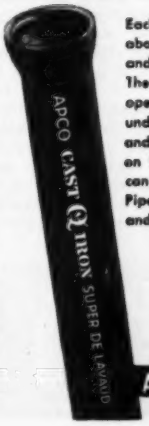

Each length of pipe we manufacture passes through the above hydrostatic test press where it is filled with water and the pressure raised to 500 pounds per square inch. The most common water works pipe is designed for an operating pressure of 150 pounds per square inch. This undergoes the 500 pounds per square inch hydrostatic test and permanent records for each piece of pipe are kept on file for inspection by our customers at all times. You can be assured with Alabama's Super De Lavaud Cast Iron Pipe. In sizes of 3" to 24" in modern long lengths. Bell and Spigot, Mechanical Joint and Flanged Pipe.

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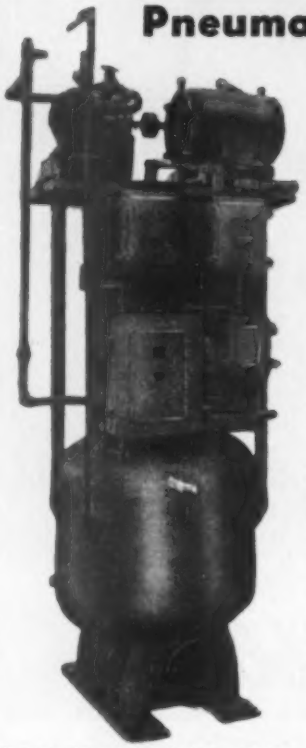
ALABAMA PIPE COMPANY

ANNISTON ALABAMA

Pneumatic Sewage Ejectors



BLACKBURN-SMITH GIVES
30 TO 500 G.P.M.
STRAIGHT UP - 150 FEET
ONCE A MINUTE
A REAL LIFT - WITHOUT FAIL

Be certain of satisfaction

No more complex piping for air and water. Eliminate clogging of screens, impellers, and shredders.

30 to 500 GPM in both single and twin units against high discharge heads.

Exclusive Modern Features

Over 50 years service has proved the worth of Blackburn-Smith Ejectors. Yet today's product has exclusive modern features such as:

1. Float and electrical float switch controls.
2. Float and pneumatically controlled snap action valve.
3. Electrode controls.

Any one of the above with or without Air Receivers. Get Catalog S50.

Compact ejector system having motor compressor assembly and all controls in one "packaged" unit.

Blackburn-Smith Mfg. Co. Inc.

51 Garden St., Hoboken, N. J.
Phones: HOboken 3-4425
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DAM REINTEGRATED WITH "GUNITE" BY CEMENT GUN CO.

Photograph above, left, shows Cement Gun Company crew preparing the spalled and disintegrated downstream side of a Virginia municipal hydro-electric dam for "Gunite." The "Gunite" was applied over reinforcing mesh to a depth of 2 inches greater than the original lines of the dam making the structure stronger and more durable than when it was originally built. To insure years of trouble-free service, "Gunite" was also applied on the upstream side to eliminate seepage through the dam. The finished job is shown in photograph below, left.

Completely pictured and described, in our latest catalog, are many instances of dam construction and repair together with many other types of "Gunite" jobs we have done. A request, on your letterhead, for Catalog C3000 will bring your copy by return mail.

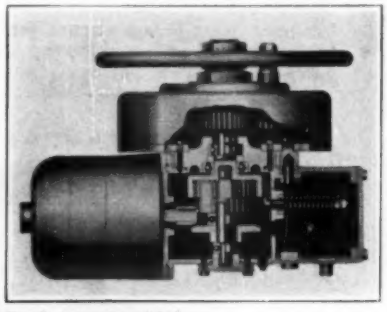
CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES – ALLENTOWN, PA., U. S. A.

MANUFACTURERS OF THE "CEMENT GUN"

new Gasoline Wright Saw that combines the versatility, simplicity, and efficiency of the hand saw with high-speed power.

The new saw consists of a reciprocating blade directly connected to a gasoline engine to form a dynamically balanced, universal wood-cutting tool. It fells and limbs trees, saws heavy timbers, cuts posts and piling—yet can be used for precision work such as trimming, notching and ripping lumber. The saw will follow a chalk line, cuts a kerf of only 3/16 inch, and leaves a mill surface on the wood. It weighs less than 25 lbs. and the 18-inch reciprocating blade is said to eliminate kicking or grabbing.

A special float-type carburetor with an exclusive wick feed allows operation of the saw in all positions, including upside down. Blades can be changed in 30 sec. and no tools are required. Sharpening is done by hand and requires only a few minutes.



Tork-Master Valve Operating Unit

1213

McBain Corp., Los Angeles, Calif., has developed the TORK-MASTER electric valve operators that are designed for efficient and economical operation of all types of conventional gate, globe, plug, butterfly, and other valves in sizes from two and one-half inches upward. Basic design provides for a wide range of operating speeds, output torque, and length of travel to accommodate various valve designs and operating conditions. Unique mounting feature provides for simple installation on valves in or out of service without alteration of the valve.

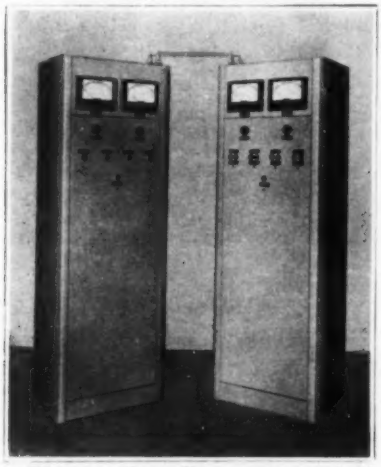
Tork-Master provides a means of operating valves through various electrical control systems and may be timed with other equipment to function automatically. High efficiency gearing requires less motor power to "crack" the valve in the opening cycle. In the closing cycle, power is cut off at the precise moment that proper seating of the valve has been attained. Stem thrust can be regulated to any predetermined value in either direc-

tion. Series "A" Tork-Master operating units are manufactured in three basic sizes with ¼ to 3 horsepower motors. All sizes available to meet current requirements to the user.

Herringbone Speed Reducers

1214

W. A. Jones Foundry & Machine Company, Chicago, Illinois, has announced a new and expanded line of Herringbone Gear Speed Reducers. In the range from 1 to 1950 Horsepower, it is the most complete line of Herringbone Speed Reducers available, according to the manufacturer.



The new line offers more standard size drives and more standard ratios for every size to enable the user to select a speed reducer that will more exactly meet his requirements.

Jones Herringbone Speed Reducers are produced in 60 standard ratios ranging from 1.27 to 1 up to 355.8 to 1. All units are available in types suitable for either coupled or overhung load applications. Nine standard shaft extension assemblies and two standard styles of bed plates provide a wide versatility for drive arrangements.

Molded Valves of Polyvinyl Chloride

1215

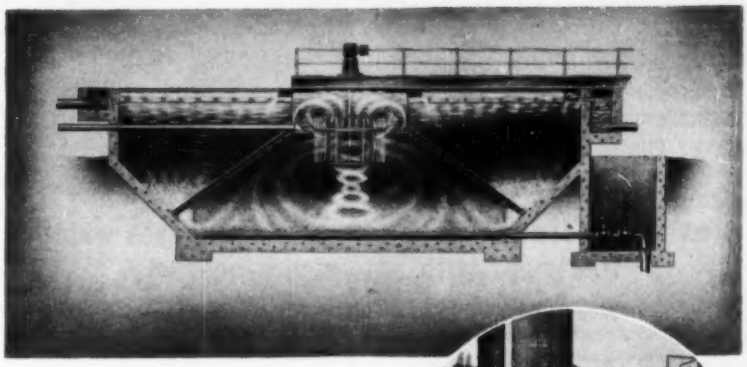
Stokes Molded Products, Trenton, New Jersey, has developed a new line of molded, Globe-type polyvinyl chloride valves.

The valves incorporate many unusual efficiency and economy features such as the ability to repack the stem with Teflon packing even under full line pressure. No packing of any type is needed at the valve seat however, and the disc is easily replaceable.

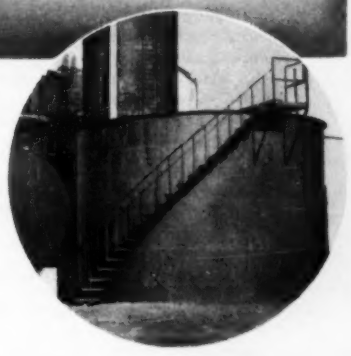
The one inch valve has been repeatedly tested at 1500 lbs. p.s.i. and operates a working pressure of 150

• WASTE WATER TREATMENT FOR SALVAGE?

• WASTE WATER TREATMENT TO PREVENT POLLUTION?



CONSIDER AMERICAN THREE-STAGE REACTORS



More and more attention is being given to waste water not only from the point of view of preventing stream pollution but also from the economy angle as well. Each industrial plant presents a particular problem—due to the quantity of water and the waste materials involved. Salvage of the water itself is becoming important in many sections of the country. American three-stage Reactors are handling the problem of waste water for industry of many kinds. Consult with American Engineers about the application of American Reactors to your problem. You'll benefit by American's more than 52 years of experience in water treatment. Send for Bulletin 500.

SERVICE SINCE 1902 — TO THE INDUSTRY

AMERICAN Water Softener COMPANY
INCORPORATED

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REACTORS • HOT PROCESS SOFTENERS • REACTORS • FILTERS • ZEOLITE SOFTENERS • CHLORIDE DEALKALIZERS • AERATORS & DEGASIFIERS
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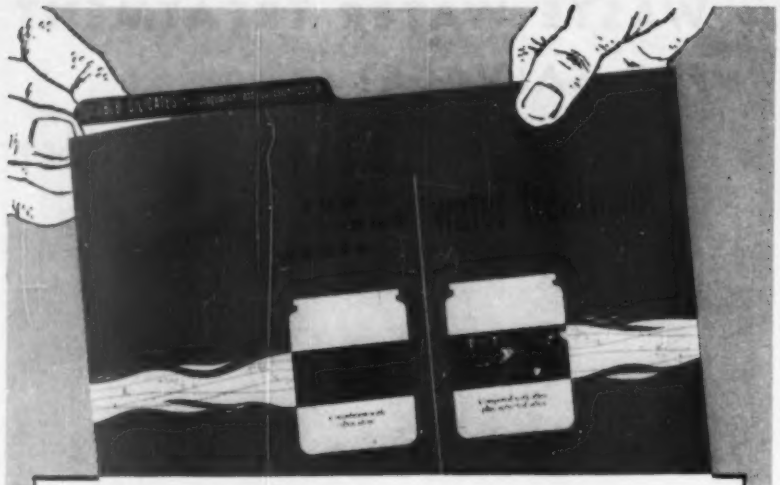
• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.



at your finger tips . . . raw and waste water treatment with activated silica sols

There is a file of bulletins and technical reprints you should have—
- for study, if you don't now use activated silica sol
- for review, if you do use activated silica

Request on your plant stationery the useful #52 file which describes the advantages of activated silica sols as coagulating aids, methods of preparing these sols, information on the N-Sol patented processes.

Philadelphia Quartz Company
1166 Public Ledger Bldg., Phila. 6, Pa.

N-Sol® Processes
PQ® SOLUBLE SILICATES

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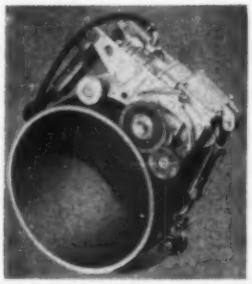
PORTABLE AUTOMATIC PIPE CUTTERS
with Pneumatic or Electric Drive

for Cast Iron and Steel Pipe from 8" to 60" diameter



- Weight: only 145 lbs.
- Clearance: 12" max. around pipe.
- Set up time: 5-10 min. by 1 or 2 unskilled men.
- Machines operate under water.
- Cuts 8" pipe in 5 min.—24" in 30 min.
- Also available: "V" cutter for welded steel pipe.

AMAZINGLY LOW COST

SIX MONTHS GUARANTEE

Write DRAWER D

H. R. PRESCOTT & SONS, INC.

QUALITY WATER WORKS SUPPLIES SINCE 1914

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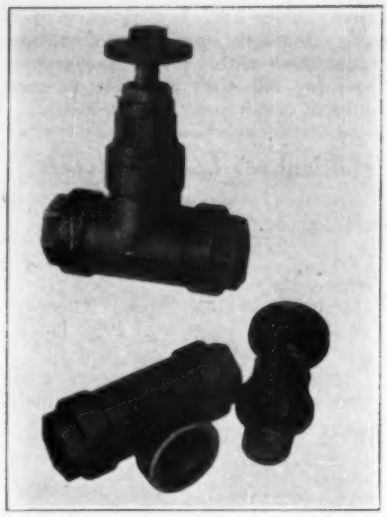


lbs. p.s.i. at room temperature. Noncorrosive and applicable throughout the many industries in places where medium pressures and temperatures not exceeding 160° F. are required. Valves are made to fit pipe sizes of ½", 1" and 1½" while maintaining full flow characteristics.

Low Cost Swimming Pool Chlorinator

1216

Fischer & Porter Co., Hatboro, Pa., has announced a new solution feed, vacuum-type, low cost chlorinator for use in swimming pools.

The dependable, ruggedly-built chlorinator is also attractive, self-contained, and creates no mopping or other cleaning problems. The chlorine flow rate may easily be read from the front of the cabinet.

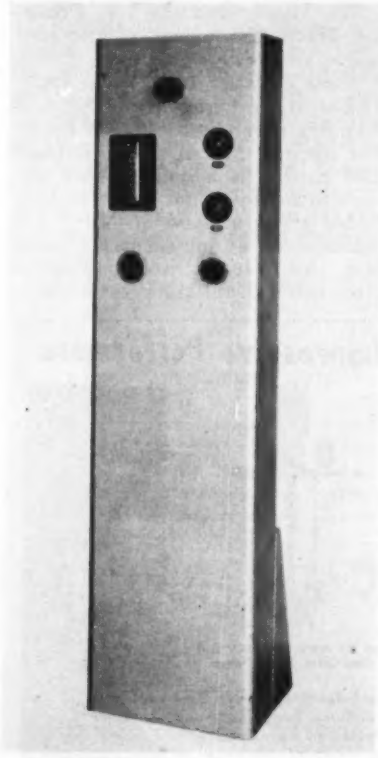
Nearly in the price range of hypochlorination equipment, the new chlorinator does not need the extra accessories required for hypochlorite

treatment. And the purchase of pure chlorine rather than hypochlorites as a source of active chlorine is much less costly. These facts, coupled with the easy maintenance and labor saving features, make the chlorinator far more desirable for swimming pools.

New Chlorine Gas Feeder

1217

Builders-Providence, Inc., Providence, R. I., has announced a new Model EVS Chlorinizer, a visible flow chlorine gas feeder especially designed to combine accuracy, dependability and safety with low cost. The Model EVS Chlorinizer is available in capacities of 4 to 400 pounds per 24 hours with a metering range of 8 to 1 and an accuracy within plus or



minus 4 per cent. The new chlorine feeder stands 66 in. high, 17 in. wide and 12 in. deep. It features a panel with recessed, eye-level Sightflo indicator, flush mounted gauges for chlorine and injector supply pressures, and adjustment knobs for chlorine feed rate and tray water flow. Other features include ease of installation, see-thru operating components, automatic safety features, elimination of chlorine ice troubles, only one chlorine diaphragm valve and short chlorine path containing no springs, stuffing boxes or piloted mechanisms.

New! **SIMPLEX**

SQUEEZE CONTROLLER

Accurately Controls Flow of Sewage, Sludge, and Trade Wastes

For the first time, heavy viscous flows can be closely regulated without affecting the moving parts of the controlling device. This solves many problems...makes possible entirely new plant designs.

The core of this unit is a time-tested venturi tube with a special throat section of flexible rubber. Differential pressure in the venturi is transmitted to a Simplex Type H Rate Setter which both measures and maintains the rate of flow desired.

If flow tends to change, Type H Rate Setter actuates the motor-driven clamping device to adjust the flexible throat area . . . quickly returns flow to the control point.

Look at these advantages. A Simplex venturi tube, the most accurate form of primary device, does double duty. It measures as it controls. The throat section is self-scouring. Viscous fluids contact no moving parts.

Write for complete details today!

Simplex Valve & Meter Company
6743 Upland Street, Philadelphia 42, Pa.

SIMPLEX®
VALVE AND METER COMPANY

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

Manhole Adapter

1218

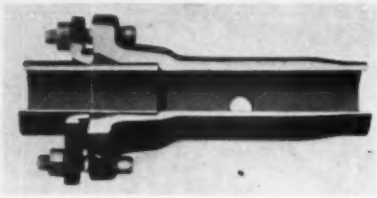
A. Reed Wilson Co., Kansas City, Missouri, has available a "Manhole Adapter" that eliminates the necessity of raising the manhole ring on resurfacing jobs.

The adapter is a tailor-made device that fits exactly into the manhole ring itself. A seat is provided to accommodate the original manhole cover. Varying elevations are possible by simply using additional adapters. Patented locking lugs and a flange hold the adapter securely and permanently in place.

2 and 2¼ Inch Cast Iron Pipe

1219

McWane Cast Iron Pipe Company, Birmingham, Alabama, has announced that cast iron pipe 2-inches and 2¼-inches in diameter and 18-feet long are now being made centrifugally with DeLavaud centrifugal casting machines.



The company recently completed construction of a new small diameter pipe foundry. It is equipped with a battery of centrifugal casting machines, annealing oven, coating vats, cement lining machine and hydrostatic testing presses.

The new 2-inch and 2¼-inch pipe is being made with bell-and-spigot or Boltite mechanical joints. It is furnished with a complete line of B & S or mechanical joint fittings. Both pipe and fittings may be ordered tar coated, uncoated or cement lined.

McWane is the only foundry in the United States making 2-inch and 2¼-inch Cast Iron Pipe in 18-foot lengths. The 2-inch McWane pipe weighs 6.2 lbs. per foot and the 2¼-inch pipe weighs 6.8 lbs. per foot, including the bell. Each length of the pipe has a tapping collar cast integrally with the pipe, behind the bell.

This small diameter pipe is even in wall thickness, straight, and easy to cut and tap. It lays fast on account of its extra length, and is easy for two men to handle by hand.

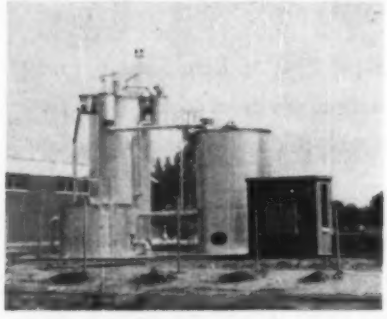
New Coatings Provide Abrasion and Corrosion Protection

1220

The Magic Chemical Co., Brockton, Mass., has announced two new Magic-Vulc Vinyl Coatings.

These coatings are easy to apply by brush, spray gun or dipping, and they dry to a tough, flexible finish. The natural state of the vinyl plastisol coating is a liquid. When applied to an object and heated to 350° F. for a few minutes, it "sets" and converts to a non-shrinking solid film. As a result, one application often gives all the thickness desired.

AN ALL STEEL
Waste Treatment Plant



The tank at the left is a Spiragester, the tank to the right is a high rate filter, and the short tank in the foreground is a non-mechanized hoppered bottom final Spiraflo Clarifier. The plant handles the wastes from an ice cream manufacturing plant.

The new Spiragester Bulletin, No. 135, will be available the last part of October, 1954.

LAKESIDE ENGINEERING CORPORATION
222 West Adams Street • Chicago 6, Ill.

These are Impressive Performers

NON-CLOG SIZES UP TO 8"
HEAVY and LIGHT DUTY
Type KS Aurora Heavy Duty Non-Clog Sump Pump
Every detail of Aurora Vertical Sump Pumps has been selected or developed with the definite purpose of achieving lasting, trouble-free and efficient operation.
Write for Bulletin 104

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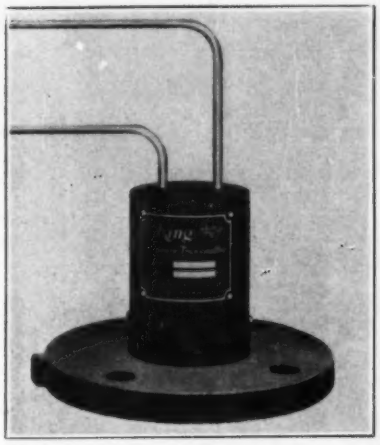


Pressure Transmitter

1221

King Engineering Corp., Ann Arbor, Mich., has announced the Model 6100F Pressure Transmitter, for use with pneumatically-operated instruments in measuring the pressure of liquids and gases—or the depth, weight, or volume of liquids —in vented and pressurized tanks. This unit provides a positive seal between the gaging system and the fluid measured, and can be used with practically any fluid.

The Pressure Transmitter has a diaphragm that is exposed to the fluid to be measured. The pressure of the fluid on the outer side of the diaphragm is continuously balanced by the pressure of air on the inner side; and this pressure is transmitted through a tube to the receiver. The air in the Pressure Transmitter has no contact with the fluid measured.

Various types of receivers can be used, such as hydrostatic gages, manometers, and pneumatically-actuated recorders or controllers. Two or more receivers can be used with the same transmitter—at different locations if desired.

This is essentially a 1-to-1 transmitter and has linear response from ½" water upward. It permits accurate readings at all pressures to 20 psi in vented tanks, and to 45 psi in pressurized tanks. It withstands overpressures of 250 psi without damage. Air consumption is less than 2 standard cubic feet per hour.

New Chempro Teflon Seal Cage

1222

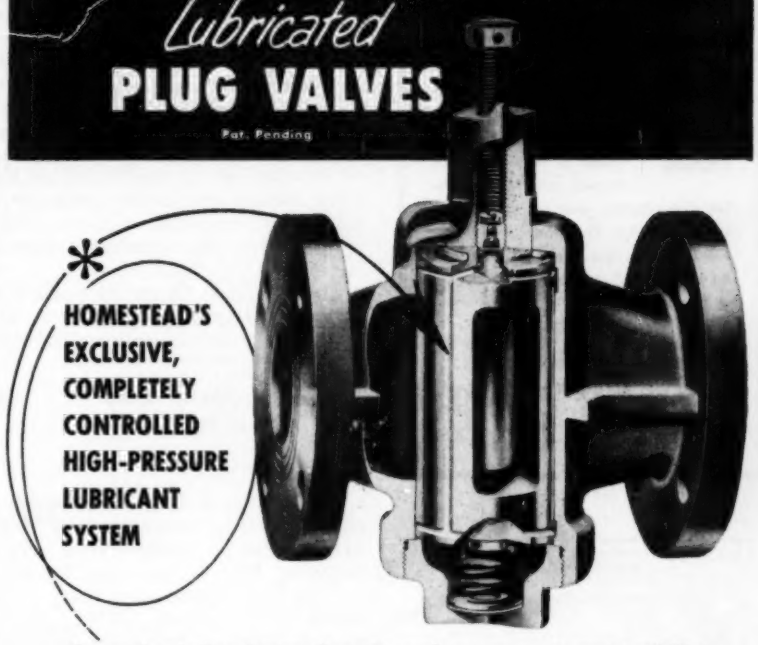
Chemical & Power Products, Inc., New York, N. Y., has developed a new one-piece, flexible Teflon Seal Cage for use with stuffing boxes on pumps, mixers, reactors and other types of processing equipment.

These seal cages were developed to overcome the handicaps experi-

No. 2* of . . .

12 REASONS WHY
YOU SHOULD BUY AND USE
LOW-PRICED

HOMESTEAD
Lubricated
PLUG VALVES
Pat. Pending



*** HOMESTEAD'S EXCLUSIVE, COMPLETELY CONTROLLED HIGH-PRESSURE LUBRICANT SYSTEM**

. . . forces chemical seal over all seating surfaces; prevents any possibility of sticking by momentary piston-like action of plug which is moved downward and returned instantly against packing ring. Provides 100% seal around ports; guarantees a completely filled system.

This is only **ONE REASON WHY** you should buy and use, *low priced* **HOMESTEAD LUBRICATED PLUG VALVES.**

HERE ARE ALL TWELVE

1. Reinforced Teflon packing ring.
2. Completely controlled high-pressure lubricant system.
3. 100% pipe area or venturi patterns.
4. No spring torsional stress.
5. No mechanical adjustments.
6. Two lubricants handle most services.
7. Extremely close tolerance between sealing surfaces.
8. Triple head-seal with Lubricant and Teflon packing ring.
9. Plug floated on Teflon washer.
10. Leak-proof double-ball and lubricant-sealed check valve.
11. Full-threaded screw assures clean lubricant.
12. Extruding lubricant shows when system is full.

FOR CATALOG AND COMPLETE DETAILS MAIL COUPON TODAY

Without obligation, send Reference Book 39—Section 5 on HOMESTEAD LUBRICATED PLUG VALVES.

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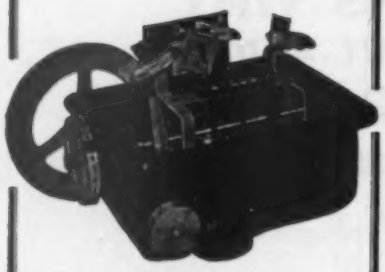
HOMESTEAD VALVE MANUFACTURING COMPANY
Serving Since 1892

P. O. BOX 42 CORAOPOLIS, PA.

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

ROTO-TROL



RF-2

WITH ALTO-TROL This 2-pump RF-2 Roto-Trol assures equal use and wear of both pumps. Each pump is operated on alternate starting cycles.

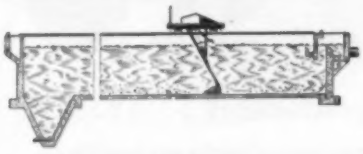
The RF-2 operates both pumps together, when required. RF-2 installations give dependable service year after year, with the minimum of attention.

Write for full data

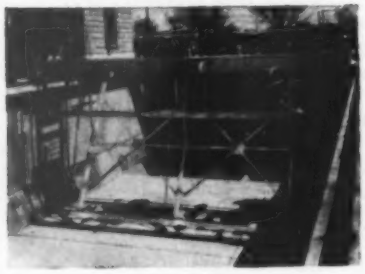
WATER LEVEL CONTROLS DIVISION

HEALY-RUFF COMPANY

783 HAMPDEN AVE., ST. PAUL 4, MINN.



Rectangular Clarifiers



Particularly suitable where space is limited or where sludge delivery is desired at one end of tank. Consists of a bridge crane spanning width of the tank supporting sludge scraper and skimmer, which move automatically back and forth.

Many of these units are now operating in sewage plants throughout the country.

This unit has also proven highly successful as an oil-water separator in the treatment of oil refinery waste water. Bulletin 31-D-15

HARDINGE

COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 Arch St. • Main Office and Works

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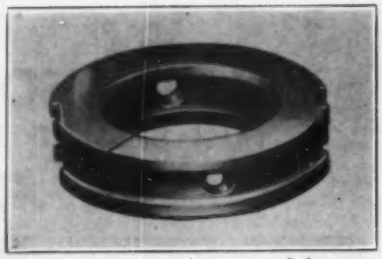


enced with two-piece metal lantern rings. Chempro seal cages, machined in one piece, can be easily snapped over the shaft without dismantling pump or pulling the shaft. Again, unlike the two-piece metal lantern rings, these Teflon seal cages will not score the shaft during operation, even at high speeds. They will last considerably longer than metal lantern rings . . . in most cases, they may be counted on to last indefinitely. Their design and construction provide a seal cage that will not bend or collapse under extreme gland pressure.

Chempro Seal Cages are available in standard or special sizes to fit any pump, mixer or agitator.

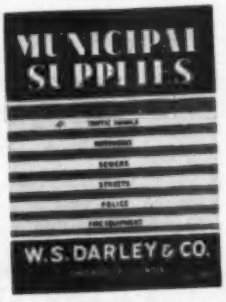
4-Foot Lengths of Clay Pipe Now in Production

1223

The Robinson Clay Product Co., Akron, Ohio, has announced that they have stepped-up production of Vitrified Clay Pipe in four-foot lengths.

Four-foot lengths are being produced in 12- through 24-inch diameters in standard and extra strength types at the company's Uhrichsville, Ohio, and Clearfield, Pa., plants. The Pottstown, Pa., plant is manufacturing the four-foot lengths in 8, 10, and 12-inch diameters.

Robinson's four-foot Clay Pipe is the result of opinions on pipe lengths expressed by sanitary engineers in a survey, as it reduces the number of joints and permits faster construction.



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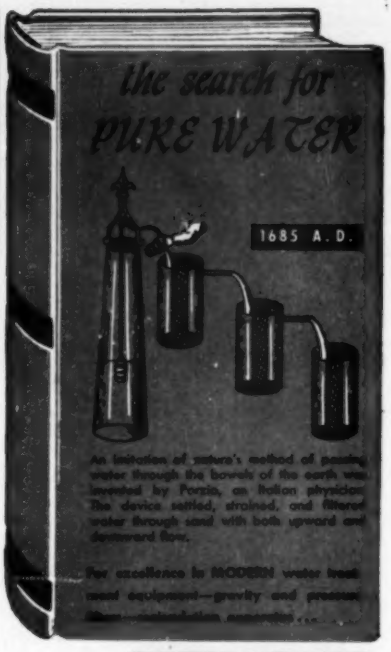
W. S. DARLEY & CO., Chicago 12



MECHANICAL EQUIPMENT BY ROBERTS FILTER MFG. CO. DARBY, PENNA.

ROBERTS FILTER MFG. CO.

607 Columbia Ave.

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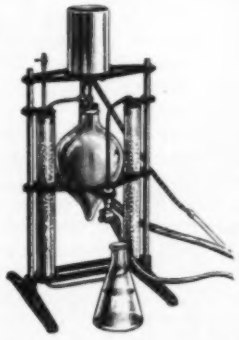
ENSLOW

STABILITY INDICATOR



For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

WRITE:

Phipps & Bird, Inc.

P. O. Box 2V Richmond 5, Va.

Literature & Catalogs

Maintenance Painting Systems For Sewage Plants

1224

The Tropical Paint & Oil Co., Cleveland, Ohio, has just released a brochure that presents **Recommended Maintenance Painting Systems for Sewage Treatment Plants** and is based on a detailed study of sewage plant painting problems, practices and experience.

The brochure presents 11 approved systems of maintenance painting. Each system applies to a certain type of surface or equipment found in sewage treatment plants. Special recommendations are made where exposures to methane, hydrogen sulfide, chlorine and lime are a factor in surface protection.

Also included in the report is a table of the 158 different types of equipment and surfaces found in sewage plants, with qualifying data as to type of surface, exposure, and whether the surface is submerged. Each equipment listing is keyed to one of the approved painting systems. This gives a handy cross-reference between the best paint system and the equipment to be protected. The systems also give recommendations for "New work" and repainting.

This brochure should prove a valuable addition to any sewage treatment plant's library.

Gate Valves

1225

The Rensselaer Valve Co., Troy, New York, has recently released a new 12 page **Gate Valve Bulletin** which features A. W. W. A. valves from 2 to 60 inches.

Discussed in the bulletin are new features which include the application of the "O" Ring Seal, improved gear ratios and a complete description of eleven different methods for end connections including mechanical joint ends for cast iron pipe and Ring-Tite joint end valves for Transite Pipe.

Valves for horizontal operation, square bottom valves, many types of gearing and gear cases, and a complete listing of the special controls available, are included.

Bucyrus-Erie Products

1234

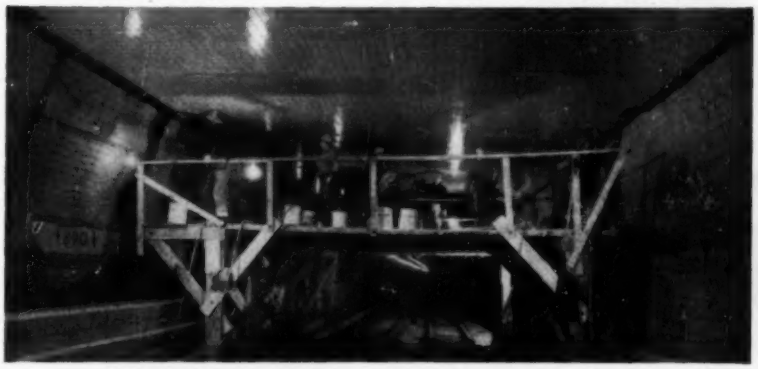
Bucyrus-Erie Co., South Milwaukee, Wis., has just released a **General Catalog** describing the com-

Underneath the river!

THORITE Patching Mortar Crew at work in Air Tunnel under East River, New York.

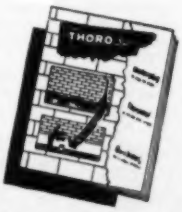
Sealing Leaks in Traffic Tunnel with WATERPLUG.

Sealing Drain Pipe Channels in Tunnel with WATERPLUG.



WATERPLUG Crew at work, before placing of tile lining, Battery Tunnels, East River, New York.

On many of the largest underground projects in the Americas and in foreign countries, WATERPLUG solves, for the contractor, his water problems. The job may be small or it may be large, the results are the same — Successful.



Get our 20-page brochure, pictorially describing, in detail, "How To Do It." It's yours for the asking. — No. 140.

Standard Dry Wall Products

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IT PAYS TO *Specify*
LEOPOLD
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Here's why—

Permanent • No corrosion or tuberculation • Equal distribution • Low loss of head • Requires only small sized gravel • No metal in contact with water!

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EASIEST... three simple steps give you the answer. Every set contains all reagents and accessories needed.

FAST . . . most tests take only a few seconds, others only a few minutes. All sets are lightweight, portable so you can make on-the-spot tests anywhere in the plant. No time wasted carrying samples back to the lab.

ACCURATE... *all liquid color standards carry an unlimited guarantee against fading.*

All standards for any one determination are housed in sturdy plastic slide. No single standards to handle.

See Your Dealer Soon!

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pany's complete line of excavating, drilling and material handling equipment.

Designed for quick reading the 70-page, 2-color catalog features concise copy, condensed specifications and over 100 photo-illustrations of the machines on specific jobs.

Tapping Concrete Pressure Pipe

1226

Price Brothers Company, Dayton, Ohio, has just published a new booklet on **How To Tap Concrete Pressure Pipe.** The handy, pocket-size, fully illustrated manual shows how you can make large taps or small service connections under pressure quickly and at minimum cost.

On-the-job photos and step-by-step instructions show you how to tap Price prestressed concrete steel-cylinder pipe with ordinary tapping equipment without interruption in service.

Using Sewage Gas To Cut Plant Costs

1227

Rockwell Manufacturing Co., Pittsburgh, Pa., has published a new booklet entitled **"Rockwell Products for Sewage Disposal Plants"** that shows how the use of sewage gas fuel in the operation of sewage plants is saving city governments many thousand dollars a year.

The booklet suggests utilization of sewage gas by disposal plants as fuel for the plant itself, for gas engines generating electricity, for pre-heating sludge, for make-up fuel in incinerators and for heat exchangers, pumping engines, laboratories and on-the-site homes.

The 20-page illustrated booklet describes how Rockwell sewage industry products can be used in cutting costs and simplifying operations of disposal plants.

Pictures and drawings illustrate Rockwell-Nordstrom valve accessories such as: cylinder and electric operators for remote and power operation; high head extensions for wrench-operated valves; and chain wheels, floor stands, watertight gear housing and road boxes —all for use with spur-gear and worm-gear-operated valves. Specification tables for valves used in disposal plants are also included.

Valve Selector

1228

Crane Co., Chicago, Ill., has just released a new 20-page, two-color,

FOR MAKING SERVICE CONNECTIONS *QUICKLY, EASILY!*

SKINNER-SEAL SERVICE SADDLE

For steel, cast iron and Transite pipe. Single massive bolt. Sizes 1" to 12" inclusive. Write for catalog.

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA

Tough and Strong
LASTS EXTRA LONG

KONIK metal beats the rigors of a tough culvert life—it resists rust and fights element corrosion. The Continental open hearth steel plus copper, nickel and chromium does it. These sheets are made especially for culvert use because they stand more rough abuse. Continental Steel Corporation, Kokomo, Indiana.

ASK TO SEE THE KONIK CULVERT METAL WARRANTY

Continental culvert distributors are glad to show the KONIK warranty . . . and the certified analysis that assures the longer culvert life of KONIK metal.

CONTINENTAL STEEL CORPORATION

FENCE • BARBED WIRE • POSTS • NAILS • ETC.

profusely illustrated pamphlet entitled, **"Choosing the Right Valve,"** to serve as a handy refresher in the application of basic valve designs for specifiers and buyers of piping equipment.

It puts at the piping engineer's elbow a great variety of valve types, each with some special qualification for service.

"It is a case of carefully matching the valve's service characteristics with the service requirements," the publication states. "It is a matter of knowing every detail of the job to be done—working pressure, temperature, fluid, volume of flow, corrosive elements, valve operating cycle, etc. Other equally vital considerations are the original valve cost, installation and maintenance costs."

Shaft Mounted Drives

1229

The Falk Corporation, Milwaukee, Wis., has just released a bulletin on **All-Steel Shaft Mounted Drives.**

The 8-page bulletin contains all essential information about these gear drives which afford users highly efficient speed reduction in limited space while effecting considerable savings in initial cost and installation expense. Subjects covered in the bulletin are: design data, selection tables, dimensions, weights, and installation photographs.

Safety And Rescue Equipment

1230

Mine Safety Appliances Company, Pittsburgh, Pa., has just published a booklet entitled **"Disaster."** The booklet was designed to assist industrial plants in choosing safety and rescue equipment for use in emergencies.

While the booklet makes no attempt to outline the organization of a disaster-control plan, it does assume the existence of groups or teams within a plant whose job it is to effect rescue and recovery operations in case of tornadoes, fires, explosions, or other types of emergencies. It is published to show just what items of equipment are needed by these teams.

Separated into five sections, the MSA booklet discusses the equipment needs of a rescue team, an engineering team, and a medical team, and contains a table-of-equipment check-chart for quick reference. It also has a catalog description and picture of each item recommended.

Maintained Accuracy...over wide capacity range
Accuracy not affected by pulsations, pressures or other variables
Compact design... to save space and foundation costs
Long-time reliability with little maintenance

CHECK THE **"BIG 4"**

ESSENTIALS FOR METER PERFORMANCE

The basic accuracy of Roots-Connersville Positive Displacement Meters stems from their simple design, with no valves, vanes or other small parts. And, because there is nothing to wear out, this accuracy is maintained for many years—with little maintenance or other supervision.

Where space is a factor, the compactness of R-C units is important. Capacity of 1,000,000 cfh, for instance, requires only 98 feet of floor area. Small meters can be tucked away in otherwise unusable space. Short-time overloads up to 50% of capacity can be handled without loss of accuracy.

These outstanding values in R-C Meters come from a century of building equipment to handle gas or air, and have been long proved in large and small installations for industry and public utilities.

For detailed information, ask for Bulletin M-152, which also contains a handy selection table to simplify selection of size and type required.

ROOTS-CONNERSVILLE BLOWER

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Specialists in handling gas and air

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Remote Reading Liquid Level Gages

1231

Jerguson Gage & Valve Co., Somerville, Mass., has just released an 8-page catalog on **Jerguson Truscale Remote Reading Liquid Level Gages.**

The catalog covers in detail the three standard types of the company's Convex Scale and Flat Scale Truscale remote reading gages, showing how these gages bring the liquid level down to where it can easily be seen.

Included are features of design and construction; description and schematics showing operation; schematics and charts graphically illustrating the three types of datum colums to meet specific needs; illustrations and descriptions of typical Truscale gage applications; and information on visible and audible alarms and Truscale repeaters.

Measuring and Control Equipment

1232

Simplex Valve & Meter Co., Philadelphia, Pa., has just published a 4-page bulletin to illustrate various types of **Control and Measuring Equipment.** General information is contained on both primary and secondary measuring devices.

Included are short descriptions and characteristics of standard and elliptical Venturi tubes as well as parabolic flumes used as primary devices to actuate secondary indicating, recording and totalizing units. Of interest are illustrations of miscellaneous types of air release and air inlet valves and the new Controlled Closing Valve, Type CCAV.

Cooling Towers

1233

The Fluor Corporation, Ltd., Los Angeles, California, has just released a bulletin entitled **"Cooling Water for Industry."**

The two-color, 36-page publication provides a description of Fluor induced-draft cooling tower construction. The bulletin, profusely illustrated with photographs, sketches, cutaway and exploded drawings showing the detail of structural and mechanical equipment, will be of particular interest to those with heat dissipation problems. The advantages of "Counterflo" design, methods of water distribution, and all components (framework, filling, sheathing, driving mechanism, etc.)—from basin to fan stack—are described in detail.

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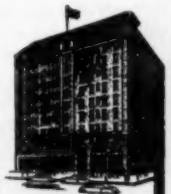

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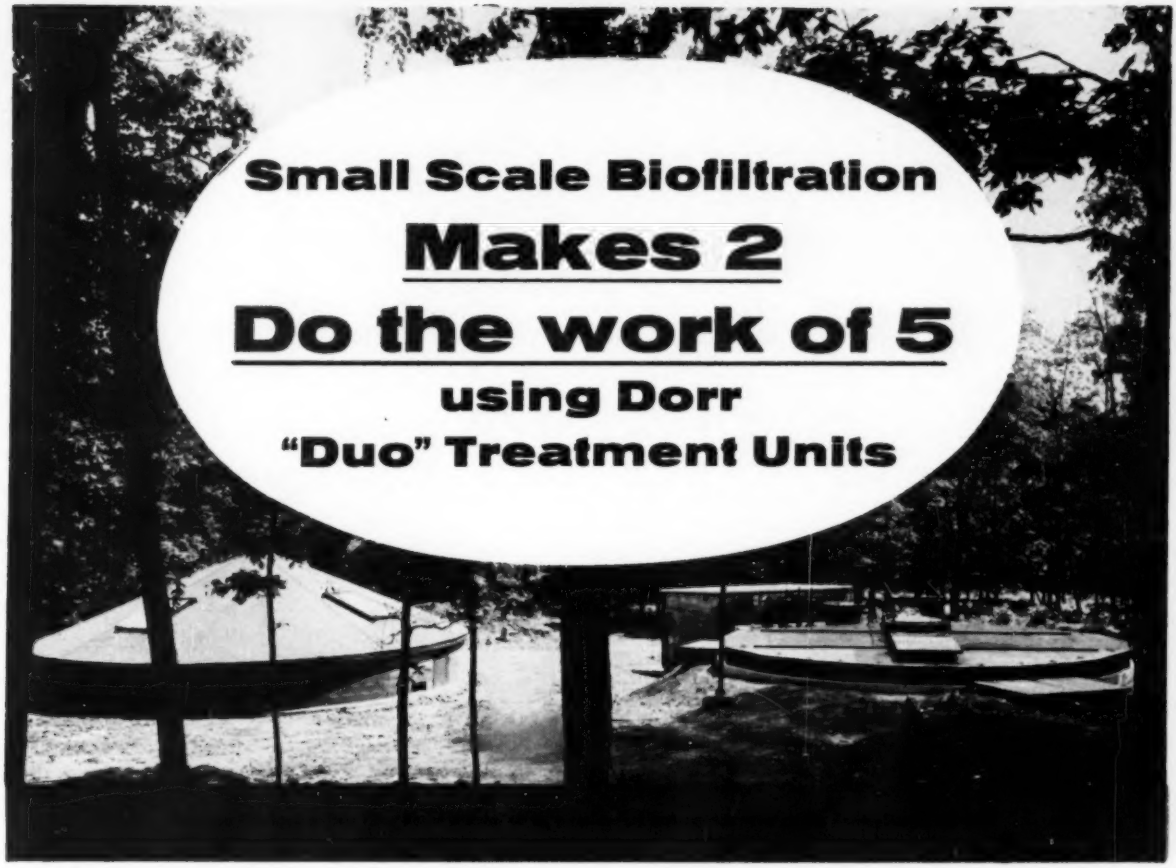

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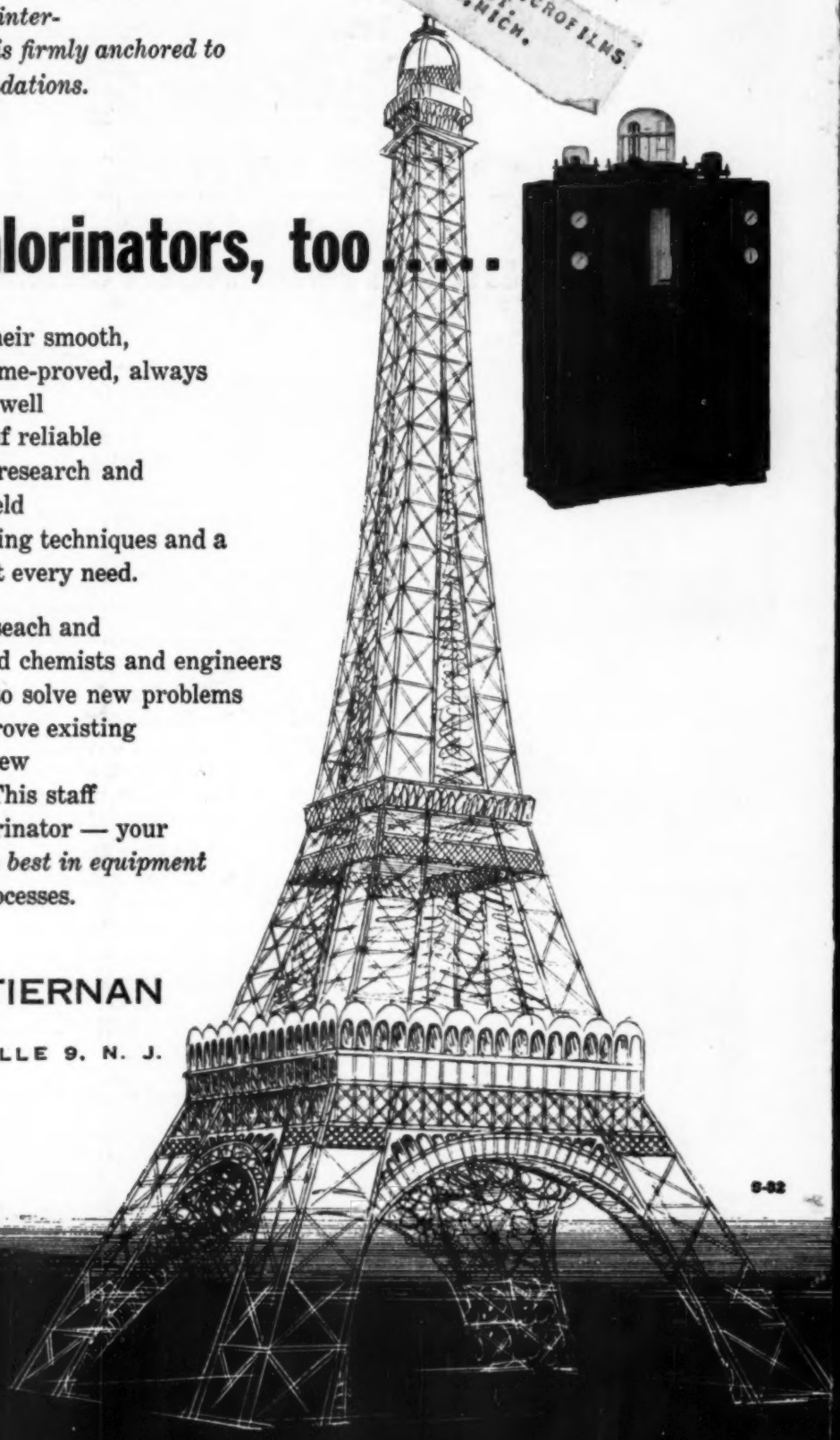

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